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BOTANICAL GAZETTE

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UNDESCRIBED PLANTS FROM GUATEMALA AND OTHER CENTRAL AMERICAN REPUBLICS. XIX.

JOHN DONNELL SMITH.

Anona Pittieri Donn. Sm. (§ ATTAE, CHERIMOLIAE Mart. Fl. Bras. **13**[1]: 14)—Folia glaberrima crasso-chartacea opaca oblonga 4-plo longiora quam latiora, apice obtuso abrupte acuminata, basi obtusa, nervis lateralibus tantum subtus conspicuis paucis a margine remote anastomosantibus. Pedunculi laterales singuli aut fasciculati graciles. Petala inter maxima lineari-oblonga.

Leaves 16–18×4–5^{cm}, nerves about 12 to the side, petioles 6–8^{mm} long. Peduncles 1–5, equaling petals, flowers puberulous. Calyx 3^{mm} high, segments deltoid. Petals 3, triquetrous, deeply concave at base, 3. 3×0. 7^{cm}. Torus hemispherical, in anthesis 3^{mm} broad. Stamens 1^{mm} long, anthers twice longer than filaments. Ovaries pubescent, with equally long and oblong style added 2^{mm} long; ovule 1, erect. Fruit not present.

Platanillo on the road to Cañas Gordas, Costa Rica, alt. 3400^{ft}, Feb. 1897, *Pittier*, no. 11108 herb. nat. C. R.

Capparis discolor Donn. Sm. (§ CYNOPHALLA DC.)—Glabra. Folia in axilla eglandulosa lineari-oblonga utrinque acuta subtus candicantia et nervis venisque atris reticulata longepetiolata. Racemus terminalis sessilis, rhachi abbreviata, pedicellis longissimis. Sepala libera orbiculari-ovata a petalis oblongo-ovalibus 4-plo superata. Stamina toro conico insidentia, antheris linearibus. Ovarium gynophoro longius.

Leaves 10–14×2.5–3^{cm}, petioles 3–4.5^{cm} long. Raceme corymbiform, rachis about 1.5^{cm} long, pedicels about 10, 2.5–4.5^{cm} long. Sepals biserially imbricate, 5^{mm} long, obtuse. Petals 18–20^{mm} long, alternately somewhat broader, obtuse at each end, exunguiculate. Stamens indefinite, a third longer than petals, anthers 4^{mm} long. Torus 4-glandular. Ovary cylindrical, a half longer than gynophore. Fruit not present in the specimens.

Forest of Rodeo de Pacaca, Costa Rica, Jan. 1891, *Pittier*, no. 3537 herb. nat. C. R.

Norantea subsessilis Donn. Sm. (§ COCHLIOPHYLLUM Delp. in Atti Soc. Ital. Sc. Nat. **12**: 181.)—(*Ruyschia? subsessilis* Benth. Bot. Voy. Sulph. 73.—*Norantea* species? Wittmack in Mart Fl. Bras. **12**^{1}: 248.)—Specimina Tonduziana tantum florigera cum hac specie phrasibus nimis brevibus descripta satis bene congruunt. Folia 8^{cm} longa 3^{cm} lata ad basin aequalem 1^{cm} lata glandulis uniserialibus e margine remotis utrinsecus circiter 10–12 notata, petiolis 2^{mm} longis. Racemus crassus usque ad 5^{cm}, pedicellis 5–6^{cm} longis in quinta vel sexta parte inferiori bractea pendula obovata 14^{mm} longa 8^{mm} lata cuculliformi atro-purpurea instructis. Prophylla calyci appressa sepaloidea. Sepala 5–6^{mm} longa, exteriora latiora quam longiora. Petala libera elliptica 1^{cm} longa per anthesin in massa decidua. Stamina circiter 13, antheris ovalibus 3^{mm} longis utrinque retusis quam filamenta complanata paulo brevioribus. Ovarium depresso-globosum 3^{mm} altum 5^{mm} latum striatum 3-loculare spurie septatum intus pubescens, stylo crasso 3^{mm} longo, stigmate subintegro. Ad *Noranteam Jussiaei* Tr. et Planch. accedit.

Páramos del'Abejonal, Costa Rica, alt. 5800^{ft}, Apr. 1893, *Tonduz*, no. 7897 herb. nat. C. R.

Malpighia dasycarpa Donn. Sm.—Folia juniora sparsim pilosa, adulta glabrata ovato-elliptica longe acuminata ad basin obtusa integra longiuscule petiolata, stipulis binis interpetiolaribus oblongo-ovatis. Corymbi axillares et terminales longissime pedunculati laxi, bracteis foliaceis, pedicellis brevissimis. Calyx 8-glandulosus. Petala breviter unguiculata. Filamentorum tubus partes liberas aequans. Ovarium hirsutum.

Younger leaves oblong-elliptical, at base acutish, canescent beneath on midrib and nerves, the older 15×7^{cm}, apex mucronulate; nerves 6–7 to the

side, prominent beneath; petioles 8–13^{mm} long; stipules canescent, 3–4^{mm} long, deciduous. Peduncles 4–6^{cm} long, bracts 1.5–3^{cm} long, primary axes 1–2.5^{cm} long, pedicels 4–5^{mm} long. Segments of calyx orbicular-ovate, 3^{mm} long, pubescent. Petals oval, with claw 2–3^{mm} long added 8–10^{mm} long, the interior one exceeding the others. Staminal tube 1^{mm} high, anthers 2^{mm} long. Ovary globose, 2^{mm} in diam., equaling the styles. Fruit not present.—Distinct by the ovary from all known species except *M. parvifolia* A. Juss.

Rio Samalá, Depart. Retalhuleu, Guat., alt. 1700^{ft}, Oct. 1891, *Shannon*, no. 217 Pl. Guat., etc., qu. ed. Donn. Sm. sub *M. glabra* L.?—Banks of Rio Torres, San Francisco de Guadalupe, Costa Rica, alt. 3400^{ft}, Nov. 1893, *Tonduz*, no. 8444 herb. nat. C. R.—San Juan del Norte, Nicaragua, June 1895, *Pittier*, no. 9653 herb. nat. C. R.

Malpighia edulis Donn. Sm.—Ramuli cum foliis subtus et inflorescentia ochraceo-tomentelli. Folia supra praeter costam nervosque glabrescentia elliptica utrinque praesertim superne acuminata hujus generis inter maxima. Umbelli axillares et terminales foliis multoties breviores, pedunculis petiolos paulo superantibus pedicellos 4–7-fasciculatos subaequantibus. Calyx 10-glandulosus. Petala trimorpha. Stamina inaequilonga.

Leaves 15–19×6–9^{cm}, petioles 8^{mm} long; stipules petiolar, subulate, 2–3^{mm} long. Peduncles 10–12^{mm} long; pedicels in middle articulated and bracteolate; bracteoles 2, oblong, 2^{mm} long. Segments of calyx tomentulose, oblong-ovate, 2^{mm} long. Inmost petal the largest, with claw 2^{mm} long added 1^{cm} long, oval, entire margin pectinate with a fringe 2–3^{mm} long; 3 interior petals more orbicular, pectinate on one side only; external petal pectinate only at its hastate-cordate base. Stamens alternately longer; the tube 1^{mm} high, shorter than the free portions of the longer filaments. Ovary glabrous, 3^{mm} high, equaling styles.—Nearest to *M. Mexicana* A. Juss.

Forest of La Carpintera, Costa Rica, Aug. 1891, *Pittier & Tonduz*, no 4394 herb. nat. C. R.—San Francisco Dos Rios, C. R., Aug. 1891, *Pittier*, no. 4409 herb. nat. C. R. Cultivated for its fruit. Popular name *Acerolla*.

BANISTERIA CORNIFOLIA Spreng., var. **discolor** Donn. Sm.—Folia subtus pube argenteo-sericea nitescentia. Paniculae floribundae folia superantes.

San Pedro de la Calabaza, Costa Rica, alt. 3300^{ft}, Oct. 1896, *Tonduz*, no. 10924 herb. nat. C. R.

Zanthoxylum ferrugineum Radlk. (EUZANTHOXYLUM Endl.; Tr. et Planch. in Ann. Sc. Nat. V. **14**: 308)—Arbor, ut videtur, inermis; ramuli ultimi in novellos florigeros lana ferruginea

obductos continuati glabrati, crassiusculi (diametro 7^{mm}), cortice plicato-rugoso cinereo; folia alterna, impari-pinnata, ad apices ramulorum conferta, novella ad petiolos rhachesque necnon subtus margineque et praesertim infima rudimentaria perulas pinnatilobas exhibentia lana densa ferruginea fugaci e pilis longi-articulatis pauciramosis vel fasciculato-stellatis contexta induta necnon, ut et adultiora, pilis albidis breviarticulatis in cellulam elongatam acutam terminatis aliisque unicellularibus adpresse adspersa, adulta (petiolo 4^{cm} longo adjecto circ. 24^{cm} longa, $10–12^{cm}$ lata) ad axillas exsudationes gummosas interdum foventas, rhachi nuda pubescente, stipulis nullis; foliola subopposita, 6–8-juga, membranacea, penninervia, ex ovato oblonga, intermedia majora (6.5^{cm} longa, 2.5^{cm} lata), acuta, basi inaequali subsessilia, margine hyalino subintegerrima, vix nisi inferiora paucicrenata, in sinubus glandula interna oleipara pellucida magna instructa, insuper subtus juxta nervum medianum hinc inde glandulis superficialibus scutatis (quas nectaria extranupitalia vocant) notata et glandulis parvis numerosissimis per staurenchyma et pneumatenchyma dissitis dense minutim pellucidopunctata, necnon glandulis lepidoideis parenchymaticis foveolis insidentibus (aegrius perspiciendis) supra subtusque adspersa, epidermide non mucigera; flores (masculi tantum suppetebant) in paniculas ad apices ramulorum inter folia novella ($6–10^{cm}$ longa) interjectas (subaequilongas) lanoso-pilosas densifloras corymboso-cymosas in polychasia capituliformia basi dichasia gerentia desinentes congesti, breviter pedicellati, pedicellis basi bracteolarum loco saepissime flores rudimentarios gerentibus; perianthii foliola 9–10, linearia ($2–3^{mm}$ longa), alia (plus minus conspicue exteriora et sepalis respondentia) breviora et angustiora, alia (subinteriora, reliquis subalterna) longiora et paullulo latiora, omnia tenuiter membranacea, flavidula, pilis glandulisque raris lepidoideis adspersa, glandulis internis punctata; staminum vestigia nulla; discus gynophorus brevis, glaber; pistillum monomerum, disco insidens (vix 3^{mm}); germen (1^{mm} vix superans) gibboso-obovatum, dorso convexum, ventre recto (floris partem posteriorem spectante) in stylum sublateralem (paullo longiorem) filiformem continuatum,

pilis furcatis vel fasciculato-stellatis tomentosum glandulisque lepidoideis tumide lenticularibus obsitum, intus glabrum; stylus basi pilis similibus, superne pilis eramosis unicellularibus puberulus, in stigma capitellatum terminatus; gemmulae in loculo supra mediam rhaphen ventralem duae, collateraliter suspensae, anatropae, epitropae (rhaphe ventrali, micropyle extus supera); fructus ignotus.

Near Alajuela, alt. 2700ft, March 1896, *Donn. Sm.* no. 6468 Pl. Guat., etc., qu. ed. Donn. Sm.

Microtropis occidentalis Loes.— Glaberrima; ramulis oppositis, i. s. atro-brunneis, nitidis longitudinaliter striatis, 1–3mm crassis; foliis oppositis, chartaceis, 8–10mm longe petiolatis, integerrimis, basi cuneatis usque subobtusis, apice obtusiuscule et plus minus manifeste acuminatis, 6–13cm longis, 2–5cm latis, i. s. viridibus subtus pallidioribus, costa supra plana vel vix prominula, subtus subprominente, nervis lateralibus utrinque circ. 6 tenuissimis ad apicem versus curvatis, tenuissime et densiuscule reticulatis, supra vix prominulis, subtus tenuissime prominentibus; inflorescentiis in foliorum axillis solitariis plerumque bis dichotome furcatis, 6–12mm longe pedunculatis, bracteis deltoideis, acutiusculis, subcarinatis, usque circ. 1mm longis, pedicellis ultimis brevissimis; floribus sub anthesi circ. 3mm diam., sepalis 4 vel plerumque 5 rotundatis inaequalibus, interioribus majoribus, ut bracteæ obscure marginatis et sub lente tenuiter fimbriatis, petalis 4–5 rotundatis albidis, staminibus 4–5 in disci 4–5-goni angulis insertis, vel, si vis, filamentis basi in discum 4–5-gonum dilatatis, sepalis oppositis et eis brevioribus, antheris parvis, cordiformibus, sterilibus, ovario tantum basi disco subimmersum, ceterum libero, conico in stylum brevem et crassiusculum angustato, incomplete 2-loculari, ovulis 4 placentae brevi centrali affixis, stigmate parvo capitellato; fructu capsulari, oblongo, apice breviter apiculato, uniloculari, circ. 12–13mm longo, dehiscente (?), monospermo, semine e basi erecto, rugoso, testa arillam simulante, albumine parco et duro, embryone magno, cotyledonibus ovali-oblongis, viridibus.

Peraffinis *M. discolori* Wall., speciae Indicae, ut genus totum adhuc tan-

tum ex India orientali notum est. Illa vix nisi disco obsoletiore a nostra specie recedit. Plantam nostrae simillimam a Schiede in Mexico in Cumbre del Obispo lectam et propter flores nondum plane evolutos atque ob patriam plane extraordinariam adhuc indeterminatam in herbario regio Berolinensi inveni.

Volcán de Poas, alt. 8000ft., March 1896, *Donn. Sm.*, no. 6470 Pl. Guat., etc., qu. ed. Donn. Sm.

Luehea meiantha Donn. Sm. (§ POLYANTHAE Schumann in Mart. Fl. Bras. **12**[3]: 152)—Folia discoloria elliptico- vel obovato-oblonga longe acuminata ad basin obtusam 3-nerviam inaequalia. Cymulae breviter pedunculatae, floribus minimis. Involucri bracteolae 3 oblongo-ellipticae 3-nerviae sub anthesi caducae pedicellis longiores sepalis linearibus dimidio breviores. Petala a sepalis 2–3-plo superata oblonga. Annulus barbatus staminodiis respondens. Stamina levissime coalita, antheris ellipticis. Ovarium trigonum 3-loculare.

Indument stellate, pale ochraceous. Leaves 16–22×5–8.5cm, sparsely pubescent above, more densely beneath, and like panicles, involucre and calyx sometimes tomentulose; basal nerves disappearing in upper third part of leaf, the lateral arising above the middle and about 3 to the side, transverse veins parallel and somewhat remote; margin above middle slightly and distantly appressed-serrulate; petioles 1.5–2.5cm long. Panicles axillary and terminal, subequaling leaves; bracteoles oblong-ovate, 3mm long, reflexed, deciduous. Sepals 8–11×1.5–2mm, acute, villous within. Petals roseate, 4×1mm, abruptly contracted into a claw that is thickened within with an entire cuneate gland 1mm long, densely barbate above gland. Gynophore 7mm high. Annulus of staminodes 0.5mm broad, the hairs 1mm long. Stamens about 25, of unequal length, the longer a little shorter than sepals, like staminodes obscurely fasciculate in five groups, anthers 0.25mm long. Ovary elongate-elliptical 2.5mm long, twice exceeded by filiform style. Capsules not present.—Anomalous by staminodes, anthers and ovary.

Jiménez, Llanos de Santa Clara, Costa Rica, alt. 600ft, Sept. 1896, *Cooper*, nos. 10212 & 10850 herb. nat. C. R.

BURMEISTERA CYCLOSTIGMATA Donn. Sm., in BOT. GAZ. **20**: 291, var. **Suerrensis** Donn. Sm.—Folia oblongo-ovata aut ovato-lancelota, floralia ovata. Calycis dentes triangulares tubo 3-plo breviores.

Suerre, Llanos de Santa Clara, Costa Rica, alt. 900ft, Feb. 1896, *Donn. Sm.*, no. 6623 Pl. Guat., etc., qu. ed. Donn. Sm.

Vaccinium Poasanum Donn. Sm.—Glabrum. Folia brevipetiolata sempervirentia integerrima oblongo-elliptica, apice contracto et obtuse acuminato, basi cuneata. Racemi axillares foliis breviores, rhachi brevi, pedicellis paucis gracilibus flores aequantibus. Corollae campaniformis lobi brevissimi. Antherae muticae poro terminali dehiscentes, loculis quam filamenta brevioribus a tubulis 3-plo superatis. Bacca 5-locularis.

Shrub 2^{m} high. Leaves coriaceous, opaque, $5–7\times2–3^{cm}$, petioles $2–3^{mm}$ long. Rachis about 8^{mm} long; pedicels 4–5, erect, $10–14^{mm}$ long, bracteate at base, bibracteolate in middle; bracts and bracteoles scariose, triangular-linear, $2–3^{mm}$ long, aristulate, fusco-ciliate. Calyx turbinate, 4^{mm} long, limb mucronate. Corolla white, 1^{cm} long, 8^{mm} broad, not contracted above; lobes broad, acuminate, spreading. Stamens 10, epigynous, a little shorter than corolla; filaments free, villose, 3^{mm} long; anthers affixed above middle, cells 2×1^{mm}, slender tubes $6–7^{mm}$ long. Berry globose, $6–7^{mm}$ in diam., many-seeded, spurious dissepiments none.

Borders of the upper lake of Volcán Poas, Costa Rica, alt. 7800^{ft}, Mch. 1896, *Donn. Sm.*, no. 6634 Pl. Guat., etc., qu. ed. Donn. Sm.—Summit of Volcán Poas, alt. 8500^{ft}, Nov. 1896, *Tonduz*, no. 10783 herb. nat. C. R.

Ardisia auriculata Donn. Sm.—Glabra. Folia immaculata sessilia maxima obovato-oblonga in triente parte superiore acuminata deorsum in lobos amplexicaules angustata. Paniculae terminales geminae pyramidales amplae, ramis solitariis, pedicellis ad apicem versus ramorum secundariorum racemosis gracilibus. Calycis lobi ovati acuti. Bacca viridis grosse maculata.

Tree of medium size; branches smooth, pallid. Leaves entire, chartaceous, pellucid, impunctate, minutely lepidote beneath, 4^{dm} long, above middle 13^{cm} and at base 4^{cm} broad, round auricles 1^{cm} long; lateral nerves spreading, arcuate; pseudo-nerves 2, distinct, remote from margin. Panicles penduculate, scarcely exceeded by leaves, pedicels $6–10^{mm}$ long. Lobes of calyx 2^{mm} long, marked by oblong spots. Berry depressed-globose, $6–7^{mm}$ in diam. Flowers not present.

Forests of Suerre, Llanos de Santa Clara, Costa Rica, alt. 900^{ft}, Feb. 1896, *Donn. Sm.*, no. 6640 Pl. Guat., etc., qu. ed. Donn. Sm.

Ardisia stenophylla Donn. Sm.—Folia supra medium subcrenulata lineari-oblanceolata acuminata in petiolum brevem attenuata punctis et lineis pellucida, nervis primariis paucis.

Panicula terminalis sessilis foliis brevior laxiflora, pedicellis ad apicem versus ramorum primariorum alternorum racemoso-fasciculatis gracilibus. Alabastra lanceolato-ovoidea. Laciniae calycinae et corollinae subsejunctae, hae quam illae altero tanto longiores. Antherae trigono-lineares, filamentis in tubum brevissimum omnino connatis.

Arboreous. Everywhere glabrous except the ciliolate calyx. Leaves crowded toward end of branchlets 14–18 × 3–3.5^{cm}, chartaceous, midrib prominent above, less conspicuous beneath; primary lateral nerves remote, about 10, arcuate, long-ascending; petioles 5–7^{mm} long. Panicle 6–9^{cm} long; branches spreading, 2–3^{cm} long; pedicels 9–12^{mm} long. Alabastra 6^{mm} long. Flowers punctate. Segments of calyx 3-nerved, lanceolate, 2.5^{mm} long, spreading before anthesis. Segments of corolla white, oblong, acute. Anthers 5^{mm} long, acute. Ovary oval, 1^{mm} long, produced into style ancipital below and equaling stamens. Berries not present.

Small tree, forests of Shirores, Talamanca, Costa Rica, alt. 300^{ft}, Feb. 1895, *Pitt. & Tond.*, no. 9173 herb. nat. C. R.— Forests of Tsâki, Talamanca, alt. 600^{ft}, Aug. 1895, *Tonduz*, no. 9586 herb. nat. C. R.

Forestiera Cartaginensis Donn. Sm.— Glabrata. Folia coriacea ovato-elliptica utrinque acuminata integra aut supra medium grosse serrata rectinervia, margine revoluto. Racemorum pedicella 5–7 plerumque oppositi. Drupa dimidiato-elliptica laciniis calycinis lineari-lanceolatis minutis suffulta, putamine striato.

Arboreous, 5–7^{m} high, branchlets rigid, the younger pubescent. Leaves not porulose, pubescent beneath on midrib, 5–7 × 2–4^{cm}, narrowed to canaliculate petiole 4–6^{mm} long. Scales of leaf buds pluri-imbricate, triangular-ovate, 2^{mm} long, ciliate. Rhachis of fruiting racemes 9–12^{mm} long, pedicels 3–4^{mm} long. Segments of calyx 1^{mm} long, ciliolate. Drupe 8–9^{mm} long, arcuate on one side, straight on the other; crowned with persistent style 1^{mm} long, 1-seeded, putamen lignose. Flowers not present. Approaching *F. racemosa* Watson by inflorescence, and *F. porulosa* Poir. by drupes; this species differs from both by its foliage.

Cartago, Costa Rica, alt. 4600^{ft}, Dec. 1887, *Cooper*, no. 5849 Pl. Guat., etc., qu. ed. Donn. Sm.— Slopes below San Rafael de Cartago, C. R., alt. 5100^{ft} Oct. 1894, *Pittier*, no. 9028 herb. nat. C. R.

Tabernaemontana Alfari Donn. Sm. (§ TABERNA a Miers pro genere proposita)— Folia breviter petiolata membranacea pellucida minute reticulata oblongo-elliptica caudato-acuminata ad imam basin acuta saepe in eodem jugo dimorpha. Cymae e

dichotomiis singulae aut binae brevissimae subtriflorae. Calycis parvi paucisquamuliferi lobi orbiculati nervosi. Corollae luteæ tubus calyce 12-ies longior paulo infra medium staminiferus et contortus. Carpella ovato-lanceolata disco usque ad ⅓ adnata.

Arboreous, 3–4^{m} high, glabrous throughout, abounding in resinous juices. The larger leaves in the pair 8–11 × 3.5–5^{cm}, abruptly prolonged into a tip 1^{cm} long; the smaller ovate 3–4 × 2–2.5^{cm}; all subsessile and with about 10 spreading nerves to the side. Cymes about 1^{cm} long, bracteose; pedicels scarcely longer than calyx and incrassate beneath the flower. Segments of deeply partite calyx 3^{mm} long, 1–5-squamuliferous, some of them occasionally naked. Tube of corolla 3.5^{cm} long, 4^{mm} wide in middle, subampliate at throat, twice exceeding the 1^{cm} broad segments, pubescent between the stamens. Anthers sessile, 6^{mm} long. Disk stout, 1^{mm} high. Follicles not seen. — Nearest to *Taberna disparifolia* Miers. — Named for Sr. Don Anastasio Alfaro, Secretary of the National Museum of Costa Rica, in memory of kind services while his guest at Suerre.

Forests of Suerre, Llanuras de Santa Clara, C. R., alt. 900^{ft}, Apr. 1896, *Donn. Sm.*, no. 6648 Pl. Guat., etc., qu. ed. Donn. Sm. — Limoncito y Vuelta, Cañas Gordas, C. R., alt. 3400^{ft}, Feb. 1897, *Pittier*, no. 11094 herb. nat. C. R. — Forests of River Naranjo, C. R., alt. 600–800^{ft}, March 1893, *Tonduz*, no. 7645 herb. nat. C. R.

TABERNAEMONTANA DONNELLSMITHII Rose, var. **Costaricensis** Donn. Sm. — Folliculi verrucosi ovales acuminati.

Borders of Rio Toro, Amarillo, Llanos de Santa Clara, C. R., alt. 1000^{ft}, Apr. 1896, *Donn. Sm.*, no. 6646 Pl. Guat., etc., qu. ed. Donn. Sm.

Tabernaemontana longipes Donn. Sm. — Folia magna obovato- aut elliptica-oblonga in acumen subito producta deorsum attenuata. Cymae longissime pedunculatae folia fere aequantes repetitus dichotomae floribundae. Calycis lobi ovati squamulis 5 muniti. Corollae tubus ad basin ampliatus calyce 3-plo longior segmentis elongato-acuminatis triente brevior ad medium staminiferus. Discus subnullus. Carpella ovata acuta.

Epiphytal, glabrous, branchlets compressed toward their tips. Leaves 20–26×7–9^{cm}, chartaceous, shining, dots and veins pellucid; nerves chiefly opposite, 12–15 to the side, spreading and ascending arcuately to the margin, like the broad midrib complanate and fuscous on lower side of leaf; petioles 2–2.5^{cm} long, dilated at base, subconnate. Peduncles geminate in the forks, 10–22^{cm} long, cymes diffuse, primary axes 3–6^{cm} long, pedicels 5–10^{mm} long;

bracteoles ovate, 1–2^{mm} long. Lobes of calyx 2.5^{mm} long, obtuse, margins hyaline, squamules subulate. Corolla white; tube cylindrical, dilated above middle, narrower than the oblong-ovoid bud of the segments, pubescent below the stamens; segments 10–12^{mm} long, dolabriform, abruptly acuminate. Anthers included, blue, 3^{mm} long. Style 3–5^{mm} long; stigma annulate below, 5 angulate above. Follicles not present.—Related to *T. citrifolia* Jacq. by structure of flowers, but differing by foliage, inflorescence, and insertion of stamens.

Hacienda de La Concepción, Llanuras de S. Clara, Costa Rica, alt. 600^{ft}, Feb. 1896, *Donn. Sm.*, no. 6650 Pl. Guat., etc., qu. ed. Donn. Sm.

FISCHERIA MARTIANA Decne., var. **funebris** Donn. Sm.—Fusco-hirsuta. Segmenta calycina glandulosa linearia 1^{cm} longa corollinis planis longiora.

Chilamate, borders of Rio Sarapiqui, Costa Rica, Feb. 1893, *Biolley*, no. 7385 herb. nat. C. R.—Forests of Santo Domingo de Golfo Dulce, C. R., Mch. 1896, *Tonduz*, no. 9936 herb. nat. C. R.

ERYTHRAEA STRICTA Schlecht., var. **tereticaulis** Donn. Sm.—Caulis sicut inflorescentiae axes teres. Flores tetrameri quam ei plantae typicae majores.

Uncultivated grounds at Surubres near San Mateo, Costa Rica, *Biolley*, no. 7076 herb. nat. C. R.

BALTIMORE, MD.

THE RELATION OF NUTRIENT SALTS TO TURGOR.

EDWIN BINGHAM COPELAND.

INTRODUCTORY.

IT is now about twenty years since turgor stepped into a prominent place in vegetable physiology. At almost the same time Pfeffer[1] demonstrated the previously unsuspected heights attained by osmotic pressure, and de Vries[2] applied it to the dark problem of the dynamics of growth. The new discovery proved a scientific gold field and turgor was immediately invoked as the solvent of a variety of problems where more familiar agencies had been found inadequate. The exaggerated importance ascribed to it in growth endured almost to the present day, when the experiments of de Vries,[3] Wieler,[4] Stange,[5] Hegler,[6] Pfeffer,[7] Schwendener and Krabbe,[8] Kolkwitz,[9] and Copeland[10] have shown that it cannot supply the energy necessary for growth (Pfeffer), that growth can occur without turgor stretching (Pfeffer, Kolkwitz), and that abnormally slow growth is more

[1] Osmotische Untersuchungen. 1877.

[2] Untersuchungen über die mechanischen Ursachen der Zellstreckung. Leipzig. 1877.

[3] Eine Methode zur Analyse der Turgorkraft. Jahrb f. wiss. Botanik **14**: 427. See also page 561.

[4] Berichte d. deutschen bot. Gesell. **5**: 375. 1887.

[5] Beziehungen zwischen Substratconcentration, Turgor, und Wachsthum bei einigen phanerogamen Pflanzen. Bot. Zeit. **50**: 253. 1892.

[6] Über den Einfluss des mechanischen Zugs auf das Wachsthum der Pflanze. Beiträge zur Biologie d. Pflanze **6**: 382. 1893.

[7] Druck- u. Arbeitsleistung durch wachsende Pflanzen. Leipzig. 1893.

[8] Über die Beziehungen zwischen dem Maass der Turgordehnung und der Geschwindigkeit der Längenzunahme wachsender Organe. Jahrb. für wiss. Botanik **25**: 323.

[9] Untersuchungen über Plasmolyse, Elasticität, Dehnung, und Wachsthum, an lebendem Markgewebe. Fünfstück's Beiträge. 1895.

[10] Über den Einfluss von Licht und Temperatur auf den Turgor. Halle a. S. 1896.

likely to increase, and abnormally rapid growth to decrease the turgor, than to be caused by variation in the latter.

In Stange's work, the substratum was merely a physical agent of varying concentration. But few salts were used, and no essential difference was observed in their action. Beyond a suggestion by Benecke [11], that the turgor may be caused by the presence of sodium as well as by that of potassium, and that the continual acquisition of the former probably serves such "secondary" functions, the relation between the chemical nature of the substratum and the turgor has never been considered. To assist in clearing this untrodden field, my investigation was undertaken.

It was hoped in beginning this study that a considerable number of chemical elements would be made to show some direct influence on turgor. But as the tables well show, this hope was not realized. With the exception of potassium, and in one case, perhaps of NO_3, the removal of any food constituent did not tend to depress the turgor, or if it did, it stopped the growth so quickly and effectively that the turgor rose. Failure to get evidence on the question in hand is then added support for the thesis already referred to,[12] that growth regulates turgor more decidedly than turgor growth.

Methods.—All the plants used as subjects of experiment were grown in water culture, in glass jars, protected from the light by heavy drying paper. The covers of the jars were wood, bored nearly through with a large auger, the rest of the way with a small one, furnishing an excellent support for the seeds. The jars for most of the experiments were of a little less than three liters capacity, larger ones of eight liters being sometimes used. During the time that the experiments lasted,

[11] Ein Beitrag zur mineralischen Nahrung der Pflanzen. Berichte d. deutschen bot. Gesell. 1894. Generalversammlung, p. 114. "Es ist absolut nicht einzusehen, warum nicht in solchen Leistungen, die weniger eng an vitale Functionen gekettet, mehr als formale Bedingungen des Lebens aufzufassen sind—nahe liegt es hier, z. B. an osmotische Leistungen zu denken—z. B. Natriummolekel für das Kalium einspringen könnten.

[12] Copeland, loc. cit.

the larger size seemed unnecessary, and was much less convenient. The seeds were germinated in clean sawdust, and when the radicles were a few centimeters in length, average specimens were selected from a large number, placed in the culture jars, and plugged fast with cotton. When the duration of the experiment demanded it, the solutions were renewed, but in many cases it sufficed to keep the jars full by occasional addition of distilled water. .

The first solutions were prepared according to de Vries' isotonic coefficients[13]: afterward they were made according to molecular equivalents. The latter is the more scientific plan, but does not differ enough to affect the results. All salts used were of absolute purity, and the utmost care was taken that the concentration was exactly that stated: for instance, in making up $MgSO_4$ solution all dehydrated crystals were removed individually before the salt was weighed; and such compounds as $Ca(NO_3)_2$, which cannot well be weighed dry, were made in solution synthetically by the writer. Clarke's atomic weight determinations were used. Making up the solutions by exact molecular equivalents secured as nearly as was possible their osmotic equality. For the individual salts, in solution alone, this might have been accomplished more accurately by taking into account their varying degrees of dissociation. But as the opportunity for unavoidable and unseen breaking up and reformation of molecules in such dilute solutions is limited only by the variety of salts dissolved, there is no way of determining the salts whose dissociation should be reckoned with. At any rate, in solutions so dilute as those used dissociation of all nutrient salts is very complete, and in practice may be regarded as quite so.

The turgor was determined by the usual method, *i. e.*, by immersing sections in a sequence of solutions of known strength of KNO_3. In the experience of the writer, no other solvent has proved itself so available for this purpose as saltpeter. It is easily and accurately prepared, keeps well, diffuses quickly

[13] Op. cit.

through the plant, and is harmless for any reasonable duration of experiment. It has, however, one theoretical disadvantage which has hitherto been overlooked, namely that, like any other crystalline salt, it dissociates in solution, and to an increasing extent with progressive dilution. Any given solution is then a little more than half as strong osmotically as one with twice the weight of dissolved saltpeter.[14] This objection might be overcome by making solutions according to the osmotic instead of per cent. strength, but since this source of error is less than that arising from the inaccuracy of the tests and the individual variations of the plants and the cells, and the correction at best would only be relative, it seemed best to conform to the established method. In the reports of the experiments the expression "turgor = 2.5 per cent." means that 2.5 per cent. KNO_3 is just sufficient to begin plasmolysis.

THE EXPERIMENTS.

Phaseolus multiflorus. Two series of cultures were carried through. The complete or standard "normal" solution was made by mixing, and diluting to one-twentieth, equal parts of the following solutions, prepared according to de Vries' isotonic coefficients:

$Ca(NO_3)_2$	9.876 %	isotonic to	0.8 æq. KNO_3
KNO_3	2.525 %	or	0.25 æq.
NaCl	1.462 %	isotonic to	0.25 æq. KNO_3
K_2HPO_4	2.597 %	" "	0.25 æq. KNO_3
$MgSO_4$	4.464 %	" "	0.25 æq. KNO_3

A. Put in cultures November 23. Radicles 3–5^{cm} long.

1. In normal solution.

		Nov. 28	Jan. 5	Feb. 13
Stem	length	11^{cm}	50^{cm}	50^{cm}
	turgor	2.5 %	2.5–3 %	2.5–3 %
Root	length	10^{cm}	——	55^{cm}
	turgor	2–2.5 %	2 %	2 %

[14] A 5 per cent. solution is only 4.67 times as strong osmotically as a 1 per cent. solution. Kohlrausch, Wied. Ann. **26**: 195.

2. In distilled water.

Stem	length	5cm	33cm	mostly dead.
	turgor	2–2.5 %	3 %	3 %
Root	length	6.5cm	——	dead.
	turgor	2 %	2 %	

3. With $NaNO_3$ and Na_2HPO_4 instead of KNO_3 and K_3HPO_4, in equivalent quantities.

Stem	length	9cm	50cm	44cm
	turgor	2.5 %	2 %	2 %
Root	length	9.5cm	——	20cm
	turgor	2.5 %	1.5–2 %	1.5 %

The solutions were renewed once during the experiment, and at its close the plants in complete solution were growing nicely. The plants tested January 5 were the largest in all the jars.

B. Put in water cultures November 30.

1. Normal.

		Dec. 17	Jan. 12	Jan. 25 (Temp. down to 10°C.
Stem	length	26cm	42cm	45cm
	turgor	2.5 %	2.5–3 %	3–3.5 %
Root	length	19cm	——	——
	turgor	2–2.5 %	2 %	2.5 %

2. Distilled H_2O.

Stem	length	7cm	19cm	——
	turgor	2–2.5 %	2.5–3 %	2.5 %
Root	length	6cm	8cm	——
	turgor	2 %	1.5 %	2 %

3. Na instead of K.

Stem	length	30cm	52cm	65cm
	turgor	2 %	2 %	2.5 %?
Root	length	19cm	——	nearly dead.
	turgor	2 %	1.5 %	2 %

4. With $CaCl_2$ and KCl instead of $Ca(NO_3)_2$ and KNO_3.

Stem	length	20cm	dead.
	turgor	2.5 %	
Root	length	14cm	——
	turgor	2 %	2 %

5. With $NaNO_3$ instead of $Ca(NO_3)_2$ ("isotonic" quantities).

Stem	length	25cm	26cm	29cm
	turgor	2.5%	3%	3%
Root	length	18cm	——	22cm
	turgor	2%	2%	2–2.5%

The beans without K flourished as well as those with it until almost the end of the experiment. As the plants become older and irregularly branched, and in many cases the main root dies and is replaced by branches, the length ceases to be a measure of the growth. But wherever it was any fair test it is included in the tables, so that the unquestionable influence of the growth on the turgor may be apparent. The cotyledons of seedlings in the last two cultures (4 and 5) were emptied more slowly than those of the others, which would tend to keep down the turgor of the growing parts. Occasional tests of the leaves of 1 and 3 showed their turgor to agree at about 3.5 per cent.

Phaseolus vulgaris. Seedlings put in the solutions December 9.

1. Normal.

		Jan. 9	Jan. 18	Jan. 27	Feb. 27
Stem	length	19cm	23cm		
	turgor	2.5%	2–2.5%	3%	3%
Root	length	9cm	10cm		
	turgor	2%	1.5–2%	2%	2%

2. Distilled H_2O.

Stem	length	10cm	(tip dead)	dead.
	turgor	2.5–3%	2.5–3%	
Root	length	8cm	8cm	dead.
	turgor	2%	2%	

3. Na instead of K.

Stem	length	19cm	25cm	27cm	
	turgor	2%	2–2.5%	2.5%	2.5–3%
Root	length	19cm	22cm		
	turgor	1.5%	1.5–2%	1.5%	2%

4. Cl instead of NO_3.

Stem	length	16cm	17cm	
	turgor	2–2.5%	2.5%	2.5–3%
Root	length	10cm	12cm	dead.
	turgor	2%	2%	

5. Na instead of Ca.

Stem	length	12cm	14cm	16cm	dead.
	turgor	2.5%	2.5%	2.5–3%	
Root	length	5cm	7cm	10cm	dead.
	turgor	2%	2%	2%	

The leaves of 1, 3, and 5 were tested January 18, and all plasmolyzed in 3.5 per cent. The plants in the complete culture were of unhealthy appearance January 27, the leaves being spotted with brown dry flecks, and the roots short and bushy. Culture 3 showed the same symptoms in milder form. The solutions were poured off and replaced with others prepared from fresh salts (see below under Pisum for composition), and a better condition ensued. The seedlings in NO_3-free solution bore very empty and colorless roots, which soon rotted; while those deprived of Ca, though dwarfed, were rugged and hardy in appearance. The power of the Leguminosæ to endure want of K better than that of Ca[15] was well illustrated by both species of Phaseolus.

Pisum sativum. Placed in solution March 13. The normal solution used in this and most of the following experiments was:

$Ca(NO_3)_2$,	0.006 æq.
KCl,	0.0025 æq.
K_2HPO_4,	0.0015 æq.
$MgSO_4$,	0.0025 æq.

With a trace of ferric chloride in the jars, as needed.

The course of turgor and growth was:

1. Normal.

		March 27	April 13	May 4
Stem	length	34cm	37cm	
	turgor	2.5%	3%	2.5%
Root	length	25cm	26cm	
	turgor	2%	1.5–2%	2%

2. Distilled water.

Stem	length	22cm	30cm	
	turgor	2%	2%	2%
Root	length	12cm	25cm	
	turgor	2%	1–1.5%	1.5%

[15] Cf. Koenig u. E. Haselhoff: Die Aufnahme der Nährstoffe aus dem Boden durch die Pflanzen. Landw. Jahrb. **23**: 1009.

3. KCl and K_2HPO_4 replaced by equivalent quantities of NaCl and Na_2HPO_4.

Stem	length	27cm	34cm	
	turgor	2–2.5%	2.5%	2.5%
Root	length	23cm	29cm	
	turgor	1.5–2%	1.5%	1.5%

4. $CaSO_4$ instead of $Ca(NO_3)_2$.

Stem	length	26cm	35cm	
	turgor	2.5%	2.5–3%	2.5–3%
Root	length	26cm	26cm	
	turgor	2%	2%	2%

The substitution of $CaSO_4$ for its molecular equivalent $Ca(NO_3)_2$ involves a slight reduction of the osmotic power of the solution. This, taken alone, would tend to lower the turgor (Stange), but it was unable to make itself felt in the result, for the turgor of these stems (4) was the highest in any solution at the close of the experiment.

Sinapis alba. Seedlings were placed in solution, such as were used for Phaseolus, December 9. This plant is not adapted to water culture, and the specimems were never vigorous, though none of them in 1 or 3 died during the experiment.

1. Normal.

		Dec. 21	Jan. 23	Feb. 8
Stem	length	5cm	5.5cm	7cm
	turgor	3%	3%	4%

2. Distilled H_2O.

Stem	length	4cm	dead
	turgor	2%	

3. Na instead of K.

Stem	length	4.5cm	5cm	5.5cm
	turgor	2%	2.5%	3%

The roots were stunted from the start, and the unusual height of the turgor of the stems may have been due to the accumulation of food, at least in part. But starch was present in 3, as well as in 1, so that their difference in turgor (1 per cent. at the close of the experiment) must be referred to the effect of the presence or absence of K, for a reasonably definite

and not too unequal quantity of sugar must have preceded the formation of starch in both cases.

Fagopyrum, the Japanese buckwheat. The normal culture was like that used for Pisum. In the table, which in this case is a compilation, the length of the parts is omitted. In relative thriftiness in the different solutions the plants agreed quite well with those grown by Nobbe[16] in his classic work on the plant's need of potassium. The time is measured from the dates when the seeds were put in water culture.

	After 9 days	After 19 days	After 33 days	After 42 days	After 57 days
1. Normal.					
Stem	2–2.5%	2–2.5%	2.5%	2.5%	2.5–3%
Root	2%	2%	2%	2%	
2. Distilled H_2O.					
Stem	1.5%	2%	2%		
Root	1.5%	1.5%	1–1.5%		
3. Na instead of K.					
Stem	2%	2%	2%	2%	2–2.5%
Root	1.5%	1.5–2%	1.5%	1.5%	
4. $Ca(NO_3)_2$ replaced by $CaSO_4$.					
Stem		1.5–2%	2%	2%	
Root		1.5%	1.5–2%		
5. $Ca(NO_3)_2$ replaced by $NaNO_3$.					
Stem	2–2.5%	2.5%	2.5–3%	3%	3%
Root	2%	2%	2%		
6. $MgSO_4$ replaced by $MgCl_2$					
Stem	2.5%	2.5%	3%	3.5%	
Root	2%	2–2.5%	2–2.5%		
7. $MgSO_4$ replaced by $CaSO_4$					
Stem		2.5%	3%		
Root		2–2.5%	2–2.5%?		
8. K_2HPO_4 replaced by K_2SO_4.					
Stem		2.5%	3–3.5%	3.5%	
Root		2%	2–2.5%		

With the substitution of $MgCl_2$ for $MgSO_4$ occurred a small increase in the osmotic power of the solution, which, however,

[16] F. Nobbe, Landw. Versuchsst. **13**: 369.

cannot suffice to explain the very high turgor of the plants grown in it (6). When $Ca(NO_3)_2$ was replaced by $CaSO_4$ the osmotic power was reduced, but here, too, the turgor surpassed the normal.

The results given in this table tally very well with those obtained on Phaseolus, Pisum, and Sinapis, as far as the latter were carried out, the only difference being in the low turgor of buckwheat grown in cultures free of nitrates. In another series the turgor of the stems grown in nitrate-free cultures rose to 2–2.5 per cent., while in normal stems it was 2.5 per cent., both tested before there was any marked difference in growth. It certainly looks as though the turgor fell because the nitrates were absent, but no such tendency could be detected in any plant tested except the buckwheat. The turgor of 5 was distinctly higher than that of 1 before any difference was noticeable in their growth. The last three cultures (6, 7, and 8) were stunted in growth by the end of the second week, which explains their extreme turgor.

Zea Mays. Two series of cultures were carried through. For the first, dating from January 16, the cultures were made as described under Phaseolus.

1. Normal.

		Feb. 6	Feb. 18	March 6	March 13	April 13
Stem	turgor	2.5%	2.5%	3%	3–3.5%	
Root	length	36cm	48cm	60cm	60cm	
	turgor	2%	2%	2%	2–2.5%	

2. Distilled H_2O.

Stem	turgor	1.5–2%	2–2.5%	1.5–2%	1.5%	1.5–2%
Root	length	29cm	34cm	47cm		50cm
	turgor	1.5%	1.5%	1–1.5%	1.5%	1–1.5%

3. K replaced by Na.

Stem	turgor	2%	2–2.5%	2.5%	2.5%	
Root	length	32cm	38cm	41cm	43cm	
	turgor	1.5–2%	2%	2%	1.5–2%	

4. Ca replaced by Na.

Stem	turgor	3%	3%	3.5%	dead	
Root	length	34cm	36cm	54cm	dead	
	turgor	2%	2%	2–2.5%		

The normal solution for the second series, beginning March 11, was that given under *Pisum sativum*.

1. Normal.

		Mar. 22	Apr. 9	Apr. 21	May 5	June 11
Stem	length	22cm	35cm	52cm	75cm	85cm
	turgor	2%	2%	2%	2.5%	3%
Root	length	36cm	41cm	66cm		76cm
	turgor	2%	1.5–2%	2%	1.5–2%	2%

1a. Containing 0.01 æq. instead of 0.0025 æq. $MgSO_4$.

Stem	length	21cm	34cm	50cm	61cm	dead.
	turgor	2%	2.5%	2.5%	2.5–3%	
Root	length	31cm	34cm	41cm	47cm	dead.
	turgor	2%	2%	2%	2%	

2. Distilled H_2O.

Stem	length	17cm	26cm	32cm	34cm	35cm
	turgor	1.5–2%	1.5%	1.5%	1.5%	2.5%?
Root	length	46cm	75cm	80cm	85cm	unsound
	turgor	1.5%	1–1.5%	1–1.5%	1.5%	1.5–2%

3. K replaced by Na.

Stem	length	20cm	26cm	32cm	32cm	dead?
	turgor	1.5–2%	1.5%	1.5–2%	1.5%	
Root	length	34cm	45cm	54cm	56cm	dead.
	turgor	1.5%	1.5%	1.5%	1.5%	

3a. KCl replaced by NaCl.

Stem	length	19cm	28cm	37cm		
	turgor	1.5–2%	2%	2%	2%	2.5–3%
Root	length	26cm	35cm	43cm		
	turgor	1.5–2%	1.5–2%	1.5–2%	1.5%	2%

3b. K_2HPO_4 replaced by Na_2HPO_4.

Stem	length	21cm	31cm	44cm	50cm	
	turgor	1.5–2%	2%	2–2.5%	2–2.5%	2.5–3%
Root	length	30cm	39cm	50cm		
	turgor	1.5–2%	2%	2%	2%	2%

3c. 0.005 æq. instead of 0.0025 æq. KCl: 0.003 æq. instead of 0.0015 æq K_2HPO_4

Stem	length	20cm	28cm	41cm	51cm	
	turgor	1.5–2%	2.5%	2.5–3%	2.5%	3%
Root	length	36cm	40cm	64cm		
	turgor	1.5–2%	1.5–2%	2%	1.5–2%	2%

4. $CaSO_4$ instead of $Ca(No_3)_2$.

Stem	length	21cm	30cm	34cm	40cm	
	turgor	2%	2–2.5%	2.5%	3–3.5%	
Root	length	40cm	52cm	103cm	110cm	
	turgor	1.5–2%	2%	1.5–2%	2%	

5. K_2SO_4 instead of K_2HPO_4.

Stem	length	24cm	34cm	41cm	47cm	
	turgor	2%	2%	2.5%	3%	3.5%
Root	length	31cm	38cm	67cm	85cm	
	turgor	2%	2%	2%	2%	2–2.5%

In measuring the "stem" (Spross) the average height of the longest leaves of all the plants in the culture was taken, hence the growth appears to have been more uniform than in any of the preceding tables, in which the length is computed only from the plants used at each time for the tests. The turgor of the "stem" (Stengel) was determined in the upper part of one of the older internodes, at a point where growth was assumed to have ceased.

The difference in turgor between 1 and 1a would probably have been produced by the addition of the same quantity (0.0075 æq.) of any harmless salt, the action being probably purely physical. The cultures 3, 3a, 3b, and 1 form a series in which the K gradually increases without any change in the osmotic strength. The result shows a strikingly uniform gradation in both growth and turgor. Up to about the point of the normal solution an increase in the relative amount of K present was certainly beneficial to the plants, but doubling the K then present (3c) may not have had any more effect on the growth, or the turgor, than the addition of the same quantity of another salt (compare 1a). At the close of the experiment the only thrifty plants were in cultures 1 and 3c. All the plants in 1a, 3, and 4 were dead, and those in 3a and 3b had only the younger leaves and roots still making a feeble show of life.

CONCLUSIONS.

The testimony of the different experiments is so uniform, and the conclusions to be drawn are so simple and manifest,

that they have been reserved for discussion until after all of the tables have been presented.

1. Potassium presented in solution to the roots of plants causes the cells of both root and stem to exhibit a higher turgor than they can do when it is replaced by sodium. There is no conceivable reason for suspecting the Na of depressing the turgor; in fact the "normal" solution in some experiments contained Na, and in others did not, without any difference appearing in the results. So we may state it, that *potassium is a factor*, direct or indirect, *in the turgor of the plant.*

2. *There is no experimental ground for attaching this significance to any other constituent of the mineral food.*[17]

It need hardly be stated here that, in common with any molecule of any kind dissolved in the cell sap, the elements if present in solution must contribute to the turgor. Nor is it impossible that they are sometimes important factors in it; but if they are, our methods cannot demonstrate it. In some instances, as when plants in an incomplete solution are able for a time to grow normally and to maintain at least a normal degree of turgor, we can say decidedly that their presence does not contribute to the turgor. Fagopyrum and Zea grown without Ca, and Zea without HPO_4 illustrate the case against these two food elements. Again, when in the absence of some food constituent the depressed growth was able to produce a very high turgor, it is improbable that the substance in question is ever a considerable part of the plant's osmotically active matter. HPO_4, Mg, and SO_4 are such substances, whose absence was accompanied by low growth and high turgor. When the absence of K, on the other hand, stunted the growth (compare 1 and 3 of Zea) the turgor still remained low.

The behavior of the various plants grown in distilled water is worthy of more than the passing notice it can here receive. Many plants will grow very rapidly in pure water until their stored-up food is exhausted. In consequence at once of the rapid growth and of the want of nourishment they have a low tur-

[17] The food product of assimilation might usually be added to this list.

gor which must remain low even when their growth stops before death. But in other cases they fall behind their better fed rivals while their reserve food is still far from used up, as though the distilled water were in itself an active agent in restricting growth, and the turgor of these plants not uncommonly becomes as high as that of those normally grown (*Phaseolus vulgaris*). Such seedlings will sometimes become accustomed to the water, and after once ceasing to elongate will put forth a luxuriant new growth. As a sample of a number of similar cases a seedling of Zea may serve, whose roots were 13^{cm} long February 10; February 19 they were still 13^{cm}; but a week later they began to grow, and by March 10 measured 30^{cm}. The roots of the first growth were remarkably thick and coarse, and but little branched; the later ones almost capillary and mesh-forming.

Except for a few plants, and a very few salts, the growth of plants in water cultures has never been studied, and will well repay a comprehensive, painstaking, comparative investigation.

Is the influence of K upon the turgor a direct one? That is, does the K itself enter into the cell sap, in whatever combination, in such quantity as to be a considerable part of the matter in solution there, and is Na unable to replace the K in this physical function? Or is it by its activity in the protoplasm that K regulates the accumulation of other substances in the sap, in which respect Na, relatively inert and unessential to the plant, could not be expected to be equally effective? At first sight, especially as K is held to play a prominent part in both the production and the translocation of the carbohydrates, one is inclined to regard the indirect course as the true one. To settle the question, seedlings of *Phaseolus multiflorus* were put into water cultures in two ten-liter jars, one containing the normal mixture of $Ca(NO_3)_2$, KCl, K_2HPO_4, and $MgSO_4$, already given under Pisum, the other different only in the substitution of Na for K. The jars were kept nearly full by addition of distilled water until June 3, during which interval the K fed plants transpired about three liters more water than did the others. The "crop" was then harvested, the roots quickly dried with filter paper,

the leaves and younger growing stems removed, and the stems and roots separated and bottled. The average turgor at the time was:

In K solution: roots, 1.9%; stems, 3.6%.
In Na solution: roots, 1.6%; stems, 2.9%.

The excess of turgor in the K plants was then about 0.3% in the roots, and 0.7% in the stems. Abundant starch was present in all the stems of both cultures. By throwing away the leaves and youngest internodes, and separating the stems and roots, material was obtained for each analysis whose turgor was known and uniform. Seedlings of *Zea Mays* were grown in the same way from April 10 until June 12. Two of the K and several of the Na plants were then dead. The roots, especially of the latter, were in bad condition, while those grown with K were very thrifty. All dead parts and the blades of the leaves were removed, and the stems and roots separated and bottled. The average turgor was:

In K solution: roots, 2.2%; stems, 3.6%.
In Na solution: roots, 1.8%; stems, 2.0%.
Excess of K over that in Na solution: roots, 0.4%; stems, 1.6%.

As soon as the material from each culture had been gathered, it was corked tightly in a bottle to prevent egress or ingress of watery vapor, and heated to 120°C. in the autoclave.[18] It was then cooled and all the sap immediately pressed out, filtered, and measured. When the sap did not exceed 20^{cc}, it was all used for analysis. The analysis consisted in oxidizing and removing all organic matter by repeated boiling to dryness with HNO_3 and $HNO_3 + HCl$; filtering and washing residue until no more Cl is dissolved; addition of NH_4OH, which caused no cloudiness; removal of Mg and any other heavy metals by excess of BaOH; removal of Ba and Ca by precipitation with $(NH_4)_2CO_3$; evaporation to dryness and heating to a white heat; and cooling and weighing. The residue should be entirely soluble KCl and NaCl. For the sake of certainty it

[18] For justification of killing the plants, see deVries, loc. cit.

was refiltered and again dried and weighed. The weight of KCl + NaCl being known, the KCl was removed with $PtCl_4$, the K determined, and the amount of Na found by subtraction.

The statistical results are embodied in the accompanying table, compiled according to Meyer and Seubert's atomic weights.

	Vol. of sap analyzed	KCl + NaCl		KCl		NaCl		K + Na
		Weight	%	%	Equivalence	%	Equivalence	Equivalence
PHASEOLUS:								
K Stem	20cc	0.187 g	0.935	0.7078	0.0931	0.2277	0.0391	0.1342
K Root	16	0.0777	0.4856	0.3731	0.0504	0.1125	0.0193	0.0697
Na Stem	12.5	0.0421	0.3368	0.2184	0.0294	0.1184	0.0203	0.0497
Na Root	16	0.072	0.450	0.1038	0.0138	0.3462	0.0593	0.0731
ZEA:								
K Stem	20cc	0.159 g	0.795	0.6064	0.0815	0.1785	0.0306	0.1121
K Root	20	0.109	0.545	0.4005	0.0538	0.1445	0.0248	0.0786
Na Stem	10	0.0206	0.206	0.0828	0.0111	0.1232	0.0211	0.0322
Na Root	3.8	0.010	0.263	0.1187	0.0160	0.1445	0.0248	0.0840

The weight per cent. of K and Na was calculated, but is omitted from the table. Comparison with v.Wolff's analyses [19] makes it appear probable that both elements are more abundant in the cell-sap than in the plant as a whole. Still this appearance may be due entirely to different conditions of growth. In the table, K and Na are represented in the form of chlorides merely for the sake of convenience, since analysis yielded them in that form. As both K and Na were present to some extent in all the sap analyzed, the sum of the two is the most suitable character by which to compare the cultures. This sum, of course, should be measured, not by the percentage weight, but by the gram-molecule (the equivalence). Multiplying the figures in the last vertical column by ten will give very nearly the osmotic power of the several mixtures of K and Na salts, measured in per cent. of KNO_3.

The difference in the aggregate of salts of K and Na between the stems of Phaseolus grown in the K- and those in the Na-

[19] Condensed in Ad. Mayer: Ernährung der grünen Gewächse, 307. Heidelberg, 1895.

bearing solutions is sufficient to create a difference in the turgor of 0.85 per cent., while the difference actually observed was only 0.7 per cent. This was exceptional, but in general the variation in the sum of the alkali metals followed that in the turgor quite satisfactorily. Only in the roots of Phaseolus did this fail. In these the per cent. of KCl+NaCl was greater in the K cultures, but the greater proportion of the lighter salt makes the mixture really more concentrated in the Na plants. The excessive turgor of the stems of Zea in the K solution (4%) was too much to explain by the accumulation of potassium. Still their sap contained 3.5 times as much of KCl+NaCl as did that of the Na plants. The stems of both Phaseolus and Zea grown in Na culture were strikingly weak in K+Na, much more effected in this respect than were the roots by the supplanting of the potassium, the plant appearing less able to make its preference felt in the organs in immediate contact with the substratum.

To make this table perfect to the chemist's eye a correction would have to be introduced for the degree of dissociation. It is said that the most completely dissociated of all salts are those of sodium. If this be true, the combined osmotic power varies a very little more widely than does the combined equivalence from the sum of the per cents. of Na and K present in any mixture. Assuming still, however, that K and Na are present as chlorides, the available data point in the opposite direction, for Kohlrausch's[20] original determinations of electrical conductivity and Landolt and Börnstein's compilation, based partly on newer figures from Kohlrausch, both represent the potassium chloride as the more highly dissociated.

From the analysis of the sap we must conclude then that *the influence of potassium on the turgor of the plant is direct.* When offered to the roots it is taken up and stored in the cell-sap, where it becomes an important part of the osmotically active material which keeps the cell and plant turgid. This function it does not share with sodium. Well known as is the useless-

[20] Ueber das Leitungsvermögen einiger electrolyte in aensserst verdünnter wässriger Lösung. Wied. Ann. **26**: 161 (p. 195).

ness to the plant of sodium as a chemical, this conclusion is still surprising. The phenomenon of turgescence is explicable by purely physical laws, and is dependent on the vitality of the plant only for the semi-permeable membrane, the living protoplasm differentiated as "Hautschicht." And yet, here where the physical properties of sodium would seem to give it a distinct advantage over the heavier potassium, leaving out of consideration the relative scarcity of the latter, we find the plant's insistence on potassium as decided as it is for the vital processes of growth and photosyntax. Indeed, in many instances (Phaseolus, Pisum) the effect of want of potassium appears in the turgor, while growth still continues normal. The plant can exhaust to the last trace the potassium of its substratum, yet it was found in appreciable quantity in the cell-sap of plants whose protoplasm was dying for want of it; as Zea (3a and 3b) after a large part of the plant was brown and dry still showed its highest turgor in the parts still living. Though the living plasma may bound itself toward the cell sap with the same "Plasmahaut"[21] which it opposes on the other side to its environment, yet the vacuole is physiologically as truly a vital part of the cell as is the alimentary canal an essential part of the human being.

The laboratory work whose results are embodied in this paper was performed at the University of Wisconsin in the laboratories of Professor Barnes and Dr. Kahlenberg, to whom I wish to express my sense of obligation for the admirable equipment placed at my disposal, and for their kindly assistance at all times.

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[21] W. Pfeffer: Zur Kenntniss der Plasmahaut und der Vacuolen, etc. Leipzig, 1890.

A LIST OF PLANTS COLLECTED BY THE CORNELL PARTY ON THE PEARY VOYAGE OF 1896.

W. W. ROWLEE and K. M. WIEGAND.

THROUGH the generosity of Mr. E. G. Wyckoff it was arranged that a party of Cornell professors and students representing the geological department of the University should accompany Lieutenant Peary upon his trip to northwest Greenland during the summer of 1896. The party was organized by Professor R. S. Tarr. At first he contemplated inviting a professional botanist to accompany him; but later, largely on account of the additional expense which this course would naturally cause, he decided to abandon this part of the enterprise and depend entirely upon his own assistants for the collection of botanical material. Considering that the main object of the expedition was geological rather than botanical study, the success from a botanical standpoint is surprising. In all about one hundred and thirty-five species and varieties of spermatophytes were collected, and the interesting series of specimens representing Brown's arctic willow (*Salix Grœnlandica*) gives positive testimony of the zeal and success with which the party studied the flora of the places where they stopped.[1] The collection from the Nugsuak peninsula is perhaps the most complete yet secured by an American expedition.

The first collection was made at Turnavik island on the Labrador coast July 20th. Some collections were made at Big island along the northern shore of Hudson strait, and at White strait, Baffin's land, July 25th to 27th. Godhavn upon the island of Disco was visited August 2d and 3d, and finally the main collecting ground of the trip, the Nugsuak peninsula, situated in lat. 74° 15′, was reached August 7th. There in three camping places the party remained until September 7th. Of

[1] Professor Tarr was aided in this work by J. O. Martin, who did by far the greater part of the purely botanical work.

the three camps given in the list of localities Camp 1 was near Wilcox head and near the open sea, Camp 2 was midway between the open sea and the ice front, and Camp 3 was near the ice front. It was from Camp 3 that excursions were made to the Devil's Thumb and to Mt. Schurman.[2] The latter, about seven miles inland from the ice front, is a mountain covered with ice except its summit. From the observations made by the party it seems certain that this mountain top was recently entirely covered by the ice cap. It is interesting on this account to notice the plants that have found their way to the mountain. This is the list:

Savastana alpina
Carex Bigelovii
Juncoides hyperboreum
Papaver alpinum
Cardamine bellidifolia
Potentilla emarginata
Cassiope tetragona
Vaccinium uliginosum microphyllum
Antennaria alpina

These are all perennial plants. In every case but few specimens of each species were seen, although all are abundant along the Greenland coast and for the most part throughout the arctic regions. Antennaria is the only one with appendages upon the fruit for wind dissemination, and Vaccinium alone has fleshy fruits. All have minute seeds. The cliffs of the mountains are favorite nesting places for birds, and no doubt they carry seeds across the ice and leave them upon the mountain. Such as have the hardiness to do so germinate and maintain themselves, all others perish.

PLANTS COLLECTED IN LABRADOR AND BAFFIN'S LAND.

Phippsia algida (Soland.) R. Br. Turnavik; Big island.
Savastana alpina (Sw.) Scribn. Turnavik; Big island.
Trisetum subspicatum (L) Beauv. Big island.
Elymus arenarius L. Cumberland sound.
Carex brunnescens (Pers.) Poir. Turnavik.
Carex glareosa Wahl. Turnavik.

Specimens much larger than those from Greenland.

[2] A map of the region about the Nugsuak peninsula will be found. Bull. Geol. Soc. Am. 8: 251–268. 1897.

Carex membranopacta Bailey. Big island.

Carex Bigelovii Torrey. Big island.

Carex sp. Turnavik island.

A form differing from *C. Bigelovii* in having comparatively shorter narrower leaves, less sheathing at the base of the stem; rootstocks more slender; staminate spikes commonly two (rarely only one) 8–15^{mm} long, approximate, acute; pistillate commonly solitary (rarely two), 10^{mm} distant from the staminate (10–15^{mm} long), acute; perigynia obovoid, obtuse, granulate, completely covered by the black scale.

Carex rariflora J. E. Smith. Turnavik.

Carex saxatilis L. Turnavik.

Eriophorum vaginatum L. Turnavik.

Eriophorum Scheuchzeri Hoppe. Big island.

Scirpus cæspitosus L. Turnavik.

Juncoides hyperboreum (R. Br.) Sheldon. Big island.

Iris Hookeri Penny. Turnavik.

Salix arctica diplodictya (Traut.) And. Big island.

Mr. Bebb considered the two species of Dr. Trautvetter (*S. diplodictya* and *S. crassijulis*) as confluent. Andersson makes them varieties, and uses Trautvetter's names for them. The characters of our plants certainly correspond to those given in Trautvetter's description of *S. diplodictya*. However, until more evidence can be accumulated it may be well to follow Andersson's conservative arrangement and consider them as varieties. We have not seen Dr. Bell's plant from Cape Prince of Wales, Hudson strait. Lange includes this variety in the *Flora Grœnlandica* and says of it "formas transitorias inter *S. arctica* Pall. et *S. Grœnlandica* (And.) Lundstr." So far as we have seen specimens the species are quite distinct.

Salix Uva-Ursi Pursh. White strait.

Two quite distinct forms were collected: Form *a*, with depressed stems, very short-peduncled aments, and elliptic-obovate very short petioled leaves 5–6^{mm} long by 3–4^{mm} wide, rounded at the apex and distinctly crenate-serrulate. Form *b*, with less depressed stems; peduncles relatively long, bearing three to four scattered leaves smaller than the leaves of the sterile shoots, aments more loosely flowered; leaves spatulate, distinctly petioled, 10–12^{mm} long by 3–5^{mm} wide, very indistinctly serrulate or entire, acute at the apex.

Salix Grœnlandica (And.) Lundstr. Turnavik; Big island; Baffin's land.

Salix herbacea L. Big island.

Salix reticulata L. Big island.

Apparently rare; only the pistillate plants were collected.

Polygonum viviparum L. Turnavik; Big island.

Silene acaulis L. Turnavik; White strait.

Melandrium apetalum (L.) Fzl. Big island.

Alsine longipes (Goldie) Coville. Turnavik.

Cerastium alpinum L. (var. *lanatum* Lindbl.) White strait; Turnavik; Big island.

Ranunculus nivalis L. Big island.

Papaver arcticum L. White strait; Big island.

Draba Fladnizensis Wulf. (*D. Wahlenbergii heterotricha* Lindbl.). Big island.

Draba alpina L. White strait.

Leaves 1^{cm} long, spatulate, densely hirsute with forked hairs; scapes 5^{cm} high; flowers racemose, petals pale yellow, twice the length of the calyx; elliptic pods, calyx and scapes hirsute with forked hairs.

Draba algida Adams. White strait; Big island.

Our plants are quite distinct from *D. alpina;* leaves large, 2–2.5^{cm} long, spatulate and very flaccid, nearly glabrous, except some marginal hairs toward the base; scapes scarcely longer than the leaves, finely pubescent with forked hairs; petals twice the length of the calyx, deep yellow; calyx and pods glabrous.

Cochlearia Grœnlandica L. Turnavik.

Cardamine bellidifolia L. White strait.

Sedum roseum (L.) Scop. Turnavik.

Saxifraga cernua L. Big island; Turnavik.

Saxifraga rivularis L. Big island.

Saxifraga cæspitosa L. Big island.

Saxifraga tricuspidata Retz. White strait.

Saxifraga oppositifolia L. White strait.

Rubus arcticus L. Turnavik.

Rubus Chamaemorus L. Turnavik.

Potentilla nana Willd. White strait.

Potentilla tridentata L. Turnavik.

Dryas integrifolia M. Vahl. White strait.

Lathyrus maritimus Aleuticus Greene (White, Bull. Torr. Bot. Club **21**: 430. 1894). Turnavik.

Many arctic and Alaskan specimens usually referred to *L. maritimus* are quite different from the more southern plants. There is some doubt, however, as to whether they should be considered as forming a distinct species. The Alaskan plants have been well described in the above cited article as var. *Aleuticus* Greene. Our material from Labrador agrees in every particular with this description, and is identical with the specimen in the Columbia University Herbarium cited by Mr. White, which we have carefully studied. This variety is characterized by a low and very slender stature; stem and lower surface of the leaves hairy; the latter smaller than in the type (1.5–3^{cm} long), elliptical, acute, and not prominently veined.

Empetrum nigrum L. Turnavik.

Chamaenerium latifolium (L.) Sweet. White strait.

Cornus Suecica L. Turnavik.

Pyrola rotundifolia pumila Hornem. Big island.

Ledum palustre L. Big island; Turnavik.

Ledum Grœnlandicum Œder. Turnavik.

Kalmia glauca Ait. Turnavik.

Phyllodoce cærulea (L.) G. &. G. Turnavik.

Cassiope tetragona (L.) Don. White strait; Big island.

Cassiope hypnoides (L.) Don. Big island.

Chamœcistus procumbens (L.) Kuntze. Turnavik; Big island.

Vaccinium uliginosum microphyllum Lge. Turnavik; White strait.

Vaccinium Vitis-Idœa L. Turnavik.

Diapensia Lapponica L. Turnavik; Baffin's land.

Menyanthes trifoliata L. Turnavik.

Castilleia pallida septentrionalis Gray. Turnavik.

Pedicularis hirsuta L. White strait; Big island.

Pedicularis lanata (Willd.) Cham. Big island.

Pinguicula vulgaris L. Turnavik.

Plantago maritima L. Turnavik.

Lonicera cærulea L. Turnavik.

Solidago Virgaurea L. Turnavik.

PLANTS COLLECTED ON THE WEST COAST OF GREENLAND.

Alopecurus alpinus Smith. Camp 3; Wilcox head.

Found mostly where Esquimaux have camped. Probably transported from place to place by them.

Phippsia algida (Soland.) R. Br. Nugsuak peninsula.

Savastana alpina (Sw.) Scribn. Camp 2; Mt. Schurman; Camp 3.

A few isolated spears only were found on Mt. Schurman.

Trisetum subspicatum (L.) Beauv. Disco island.

Poa alpina L. Godhavn, Disco; Camp 3; Wilcox head.

Poa flexuosa Wahl. Godhavn, Disco; Camps 2 and 3; Wilcox head; Devil's Thumb. Quite common on Disco island and at Camp 3.

A large and small form occurs; the taller according to Mr. Martin grows in gull's droppings, especially in shady places. It has been described as

Poa flexuosa elongata Blytt. Nunatak no. 1; Nugsuak peninsula.

Festuca duriuscula L. Godhavn, Disco.

Atropis vilfoidea (And.) Row. & Wieg. n. nom. (*Catabrosa vilfoidea* And. Vet. Akad. Forh. 254. 1862.) (*Glyceria vilfoidea* Th. Fr. Kgl. Vet. Akad. Ofv. 139. 1869.) Wilcox head.

Carex glareosa Wahl. Devil's Thumb.

Carex lagopina Wahl. Godhavn, Disco.

Carex nardina Fries. Nunatak no. 1; Nugsuak peninsula; Disco island.

Carex capitata L. Godhavn, Disco.

Carex Bigelovii Torr. Godhavn, Disco; Camp 2; Mt. Schurman; Devil's Thumb; Nugsuak peninsula.

Carex rigida Good. Camp 3.

Carex stans Drej. Wilcox head.

Carex rariflora J. E. Smith. Found growing in Sphagnum on a hillside on Disco island.

Carex scirpoidea Michx. Nunatak no. 1 and Camp 2 Nugsuak peninsula.

Eriophorum Scheuchzeri Hoppe. Wilcox head; Camp 2; Godhavn, Disco.

Juncus trifidus L. Godhavn, Disco.

Juncoides parviflorum (Ehrh.) Coville (var. *fastigiata* Buch.), Godhavn, Disco.

Juncoides spicatum (L.) Kuntze. Disco island.

Juncoides hyperboreum (R. Br.) Sheldon. Disco island; Camps 2 and 3; Wilcox head; Mt. Schurman; Nunatak no 1.

Juncoides nivale (Laest.) Coville. Camps 2 and 3.

Our specimens are *Luzula arctica* of Lange's *Flora Grœnlandica*, characterized as having leaves long acuminate, and seem to agree with Læstadius' description of *L. campestris* var. *nivalis*, but differ from Buchenau's description of *L. arctica* with leaves obtuse at the apex. They have very slender scape-like stems 12^{cm} high, terminated by a single dark-brown spike, rarely with a second peduncled one; whole plant glabrous; leaves rosulate at the base of the stem, flat and broadly subulate, tapering from the 3^{mm} wide base to the fineness of a hair at the apex, 3^{cm} long.

Tofieldia palustris Huds. Rather common in the sand along the shore on Disco island.

Salix glauca L. Godhavn, Disco.

Some forms of *S. Grœnlandica* closely resemble this species.

Salix Grœnlandica (And.) Lundstr. Godhavn, Disco; Wilcox head; Camps 2 and 3.

Specimens of this species showing the greatest variability were collected at nearly all the stations. Eight forms seem to be represented, some of which are quite distinct. Andersson's varieties *angustifolia* and *latifolia* were both collected.

Salix Grœnlandica leiocarpa (And.) Lundstr. Godhavn, Disco; Wilcox head.

This very distinct form was no. 224 of the Peary Auxiliary Expedition of 1894.

Salix herbacea L. Wilcox head.

Betula nana L. Godhavn, Disco; Camp 2. Mostly on rocky talus.

Oxyria digyna Hill. Wilcox head; Godhavn.

Polygonum viviparum L. Disco; Devil's Thumb; Camps 2 and 3; Wilcox head.

Silene acaulis L. Godhavn, Disco; Camps 2 and 3.

Viscaria alpina Fzl. Disco.

Melandrium triflorum (R. Br.) Vahl. Camp. 2; Wilcox head.

Melandrium involucratum (Ch. & Schl.) Lange. Disco; Nunatak no. 1; Nugsuak peninsula.

Arenaria biflora (L.) Wahl. Godhavn, Disco.

Ammodenia peploides (L.) Rupr. (var. *diffusa* Hornem.). Godhavn, Disco.

Alsine longipes (Goldie) Coville. Disco island.

Cerastium alpinum L. (var. *lanatum* Lindbl.). Godhavn; Devil's Thumb; Camp 3; Wilcox head; Nunatak no. 1.

In clefts of rocks; most luxurious where gulls have nested. It is much matted in its growth like our garden chickweed which it much resembles.

Cerastium trigynum Vill. Disco island.

Ranunculus pygmæus Wahl. Godhavn.

Papaver alpinum L. Godhavn; Mt. Schurman; Camp 3; Devil's Thumb; Wilcox head.

Draba crassifolia Graham. Disco island.

Flowers apparently white.

Draba hirta rupestris Hartm. Godhavn; Nunatak no. 1; Devil's Thumb.

Draba corymbosa R. Br. Godhavn.

Draba corymbosa grandidentata Lge. Godhavn.

Cardamine bellidifolia L. Mt. Schurman.

Cardamine bellidifolia sinuata J. Vahl. Camp 2.

Leaves dentate and flowers larger than in the type.

Arabis alpina L. Godhavn. In rich soil.

Arabis alpina glabrata Hartm. Godhavn.

Saxifraga cernua L. Godhavn; Camp 3; Nunatak no. 1.

Saxifraga rivularis L. Godhavn; Nunatak no. 1.

Saxifraga cæspitosa L. Disco island; Wilcox head.

Saxifraga cæspitosa palmata Hartm. Disco island.

Saxifraga tricuspidata Rottb. Godhavn; Devil's Thumb; Camps 2 and 3; Nunatak no. 1.

Saxifraga comosa (Poir.) Britton. Wilcox head; Camp 3.

Saxifraga nivalis L. Godhavn; Camp. 3.

Saxifraga oppositifolia L. Devil's Thumb. In comparatively well drained soil.

Potentilla rubens Vill. Godhavn.

Potentilla nivea pinnatifida Lehm. Godhavn.

Our specimens seem to be nearer this variety than the type. The plants

are very large (3^{dm}), much branched; flowers cymose (18^{mm} diam.), petals one-half longer than the calyx; leaflets 3 (rarely 4), tomentose beneath, oblong, pinnately cleft, terminal 2.5–3.5^{cm} long.

Potentilla Vahliana Lehm. Wilcox head.

Potentilla emarginata Pursh. Camp. 3; Mt. Schurman.

Besides the ordinary form a large form was collected on Nunatak no. 1 with very long and slenderly petioled leaves (15^{mm} long), terminal portion of the leaf pedicelled (pedicel 3–4^{mm} long), acutely and very coarsely incised; stems long and runner-like (15–23^{cm}).

Sibbaldia procumbens L. Godhavn.

Dryas integrifolia M. Vahl. Godhavn; Camps 2 and 3; Wilcox head.

Alchemilla alpina L. Godhavn.

Empetrum nigrum L. Camps 2 and 3; Devil's Thumb.

Chamænerium angustifolium (L.) Scop. Godhavn.

Chamaenerium latifolium (L.) Sweet. Camp 3; Devil's Thumb.

Chamaenerium latifolium tenuiflorum Fr. Godhavn.

Epilobium alpinum L. Disco island.

Epilobium Hornemanni Reich. Godhavn.

Pyrola rotundifolia pumila Hornem. Camp 3; Devil's Thumb; Godhavn.

Ledum palustre L. (var. *decumbens* Lange). Disco.

Phyllodoce cærulea (L.) G. & G. Godhavn; Camp 2.

In rather dry places.

Cassiope tetragona (L.) Don. Camps 2 and 3; Mt. Schurman; Disco.

The party used this as material for beds while in camp.

Cassiope hypnoides (L.) Don. Disco; Camps 2 and 3.

Chamæcistus procumbens (L.) Kuntze. Camp 2.

Vaccinum uliginosum microphyllum Lge. Camps 2 and 3; Mt. Schurman; Godhavn.

Only a single specimen of this was found on Mt. Schurman.

Rhododendron Lapponicum (L.) Wahl. Ice front, Camp 3.

Diapensia Lapponica L. Camps 2 and 3.

Armeria Sibirica Turcz. Disco.

Pneumaria maritima (L.) Hill. Disco.

Leaves in our plants not glaucous.

Veronica alpina L. Disco island.

Our specimens grade gradually from stout forms with elliptical leaves to slender ones with linear acute leaves.

Bartsia alpina L. Godhavn.

Pedicularis flammea L. Godhavn.

Pedicularis hirsuta L. Godhavn.

Pedicularis Lapponica L. Godhavn.

Campanula rotundifolia Langsdorfiana (A.DC.) Britton. Between Camps 2 and 3.

Upon face of cliffs.

Campanula uniflora L. Godhavn.

Erigeron uniflorus pulchellus Fr. Godhavn.

Antennaria alpina (L.) Gaertn. Disco; Camps 2 and 3; Mt. Schurman.

Arnica alpina (L.) Olin. Disco; Camp 2.

Taraxacum officinale Weber. Godhavn.

Artemisia borealis Pall. Godhavn.

CORNELL UNIVERSITY.

BRIEFER ARTICLES.

DISGUISES IN BUD ARRANGEMENT.

THE law regarding the general arrangement of buds is very simple, but it is not always easy to make all the phenomena of leaf, branch, and flower arrangement agree with the law. This is especially true in the various forms of inflorescence, because in the floral system there is a decidedly greater tendency of potential buds to develop than in the case of the vegetative system; and as flowers can perform their important duty in a somewhat crowded condition as well as when scattered, while leaves must be scattered, the internode is not an important factor in inflorescence as it is in the leaf bearing stem.

One of the simplest disguises of the origin of an inflorescence is seen in various Vitaceæ, Phytolacca, Enslenia, Gonolobus, etc., where each inflorescence terminates the axis, and the succeeding internode is produced by the highest axillary bud. This new internode differs little in size from the preceding, while the stem bearing the inflorescence remains small and is thus thrust aside by the development of the axillary bud. This results in placing the inflorescence opposite a leaf, where it really, but not apparently, terminates the axis. To strengthen this disguise, a small bud is frequently developed in the axil of the leaf opposite the inflorescence, making it appear that the terminal bud has continued the vegetative axis, in which case the inflorescence could have no normally placed bud from which to develop. The nature of this little bud will be considered later.

A still more complete disguise is found in many of the Solanaceæ, where the leaf, which in the above cases stands directly opposite the inflorescence, is carried up by adnation the whole length of an internode from its normal position, leaving the inflorescence apparently branching from an internode instead of a node (*fig. 1*). This also results in an unusual arrangement at the node above, where there are two leaves at one node but not opposite. By tearing a portion of the bark bearing the misplaced leaf down to the level of the inflorescence, both the node bearing the inflorescence and the one above will appear normal.

Physalis goes still farther in this form of disguise, and were one not familiar with a less disguised form, as *Solanum nigrum*, it would be very difficult to determine the normal arrangement of the parts. The internode, which in Solanum separates the inflorescence from the node below, fails to develop in Physalis, thus leaving a flower at a node to which it does not belong and hence neither axillary nor opposite to any leaf at that node. At the same time the leaf which properly opposes the inflorescence is carried upward, as in Solanum, to the level of the next node. If we conceive a node to be formed between the present nodes and the flower raised to it from the node below, and the leaf lowered to it from the node above, the nodes will all be perfectly normal. If the inflorescence of Solanum is split down to the node below, it will be seen to present precisely the arrangement of the Physalis node, and the irregularities may be very easily removed by cutting the flower from one node, and then the leaf to which that flower belongs from the node above, and so on.

FIG. 1. A portion of stem of *Solanum nigrum*, showing position of the inflorescence and of the leaf belonging to the same node.

Dichotomy is another common peculiarity among the Solanaceæ. This is due to the equal development of the primary axis and an axillary branch, and its nature is often obscured by the leaf of the node below being carried, by adnation, to the point where the stem forks, while the leaf to which the lateral branch of the fork is axillary is carried up in a similar manner to the first node of that branch.

The bract of *Tilia Americana* (*fig. 2*) shows how the removal of a bract from its normal position may serve a very useful purpose. This bract is primarily the homologue of a bud scale, or more remotely of a petiole of a leaf. Its midrib is adnate to the peduncle for half the length of the bract, and being persistent with the fruit serves as an efficient means of seed dispersal. There has been some difference of opinion as to the homology of the bract of Tilia, but a careful examination will suggest very forcibly that the bract is a case of adnation

rather than an outgrowth of the peduncle, that it has a foliar rather than a cauline origin. Further proof that this bract is a leaf organ may be found in the buds (represented in cross section in *fig. 2*). Every bud where an inflorescence does not occur has the first bud scale

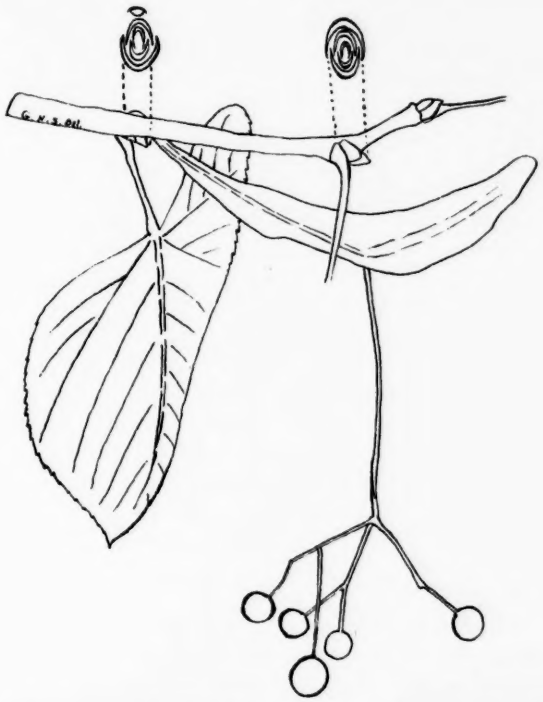

FIG. 2. Infloresence and bract of *Tilia Americana*, with cross section of two buds.

on the upper side. Where an inflorescence appears it always arises from the same position relatively that the first bud scale occupies in other buds, while the bud occurring at the same node with the inflorescence invariably has the first bud scale below.

The removal of a subtending leaf or bract from its normal position is not uncommon. Neither is it always so constant in a species as it seems to be among the Solanaceæ. In a number of species studied the bracts were usually normally placed, but frequently appeared above the node

to which they belonged, or stems were adnate for some distance above the bract, so that the bract appeared to be below the node.

Leaf organs are also frequently absent, but there is always a real or potential bud where the leaf or bract should have been had it been present. Several causes may act to bring about the absence of bracts, but crowding the parts in the bud seems to be the chief cause. The inflorescence of *Sambucus Canadensis* is very interesting in this connection. At the primary division of the inflorescence the five rays are nearly equal, and the four lateral rays are each subtended by a bract which exhibits considerable variation in its position, being frequently above its normal position or below the apparent node. At the secondary, tertiary, etc., divisions of the inflorescence, the parts of the whorl are very unequal, and the larger rays which come in contact with the enveloping leaf organs in the bud, and which thus bear most of the pressure, have the subtending bracts entirely obsolete, while the smaller inner rays from the same nodes, being in the center of the inflorescence, are subjected to less pressure and have minute bracts present.

Without an amendment to the law of bud arrangement a true anomaly occurs in the spikes of *Verbascum Thapsus*. In early development the spike does not appear complex, but in the older spikes or older portions of the spike each bract is seen to subtend a group of buds as shown in *fig. 3*. In the younger portions of the spike the upper bud (1) of the group is the only bud present, and is nestled close in the axil of the bract, hence it is a true axillary bud. This bud is removed from the axil by subsequent growth and another bud (2) takes its place, and is evidently just as truly an axillary bud as the first. About the time this second axillary bud appears, accessories (3, 3) appear at the base of the primary axillary bud, each being subtended by a bract, as is normal with accessory buds. Further growth also removes the secondary axillary bud from the axil of the bract, and a tertiary axillary bud (5) is developed in the axil, while accessories (4, 4) appear at the base of the second axillary bud. I have chosen to call these primary, secondary, and tertiary buds because they in nowise differ from one another except in the time of their appearance.

In a previous paper[1] it was suggested that the bud which produces an extra-axillary branch in the case of *Juglans cinerea* is really the true axillary bud, because no accessory bud was found which regularly pro-

[1] BOTANICAL GAZETTE, **21**: 168. 1896.

duced a branch except in case the axillary bud was destroyed or produced some other organ. Further investigation shows this to be a case precisely similar to that of Verbascum, and the extra-axillary branch is produced by the primary axillary bud while a secondary bud appears in the axil of the leaf. This also occurs in *Juglans nigra* and species of Carya, though here the primary axillary bud is not so far removed from the axil and the secondary remains quite small. To the same class belong those minute buds which occasionally appear in the axil of a leaf after the primary axillary bud has developed into a branch, as in the above mentioned cases where the terminal bud produces an inflorescence and the vegetative axis is continued by the axillary bud.

FIG. 3. A group of buds subtended by a single bract in *Verbascum Thapsus*. The numbers indicate the order of development and also of flowering.

There is nothing anomalous about the whorled flower clusters that occur in the axils of the leaves of certain of the Labiatæ, Polygonaceæ, etc., except that the axis of the inflorescence is very much reduced. This is not always plainly evident, but the illustration of *Mentha Canadensis* (*fig. 4*) shows an inflorescence in which this reduction is not complete, and the whole cluster of flowers is plainly seen to be simply a much reduced cyme. Being familiar with such an inflorescence as that of *Mentha Canadensis* it is not difficult to trace the same formation in cases where the reduction is complete and the flowers are sessile. Thus in *Lycopus sinuatus*, for example, the flowers are all sessile, but they may be seen to be divided into two lateral groups with the single flower terminating the central axis.

In Polygonum fascicles of flowers are surrounded at the base by a group of minute scarious bracts, to which the individual flowers are axillary, while in Rumex the flowers are so numerous and so crowded that the bracts are obsolete, but the origin of the flowers is undoubtedly the same as that of the flowers of Polygonum.

The origin and normal arrangement of buds may frequently be inferred from the order of flowering, for anthesis takes place in the order of development. Ordinarily, in a fascicle formed by the reduction of a determinate inflorescence, the flower which blooms first terminates the central axis of the cluster, and the next to bloom will be the terminal buds of the lateral clusters, and so on. In a dense

indeterminate inflorescence the lower or outer buds normally bloom first, because the terminal bud continues vegetative while the axillary buds are forming floral organs. As the order of anthesis and that of development are the same, whatever affects the order of development will in like manner affect the order of flowering. Thus, if for any cause the terminal bud of a normally indeterminate inflorescence develops floral organs before the last lateral buds have attained a like state of development, a mixed inflorescence results, as has been occasionally seen in Digitalis.

FIG. 4. Verticillate inflorescence of *Mentha Canadensis*.

A very interesting case of variation from the normal order of development is seen in the genus Dipsacus, where the dense crowding of the flowers in the head forces the lower buds down against the involucre and so retards their development. The next circle of buds is not crowded so much, and the development is proportionately less retarded. The pressure becomes less and less as the buds occupy a higher and higher position in the head, until at about the middle a point is reached where the bud pressure is so much reduced that from that point to the apex of the head a normal order of development obtains, showing Dipsacus to have a normally indeterminate inflorescence. In flowering the center of the head blooms first, and thence one flower zone proceeds upward according to the normal order of development, and another downward according to the order of development brought about by bud pressure.

SUMMARY.

1. Most cases of branch and flower arrangement may be explained by the law that a bud, real or potential, occurs in the axil of every leaf, and terminates every axis.

2. If a bud is removed from the axil of a leaf by adnation or by development into a branch, a secondary axillary bud may form in the axil of the leaf, and if that too is removed a tertiary axillary bud may form, etc.

3. Bud pressures explain reduction of bracts and their failure to appear, as well as many modifications in the normal order of anthesis.

—GEO. H. SHULL, *Yellow Springs, Ohio.*

NOTES ON FLORIDA PLANTS.

THE collections made the past season by Mr. A. H. Curtiss, for the current fascicle of his valuable series of Florida plants, contain so many species of unusual interest, either as novelties or as exhibiting striking additions to our knowledge of geographical ranges, that the following notes may prove of interest:

RYNCHOSPORA FUSCA Ait. Hort. Kew. (ed. 2) 1: 127.

This northern species, not previously reported south of Delaware, was found by Mr. Curtiss along moist roadsides at Milton, west Florida, July 8, 1897 (no. 5929).

Cyrtopodium ecristatum, n. sp.— Scape slender, erect, 4 to 12^{dm} high, from one or more roundish tubers 2 to 2.5^{cm} in diameter: leaves erect, lanceolate or linear-lanceolate, strongly 3-ribbed, 2 to 5^{dm} long: racemes loosely or closely flowered, 6 to 12^{cm} long, bracts lance-acuminate or linear-attenuate, the lowest 3 to 5^{cm} long, much exceeding the small flowers, the uppermost shorter, about equaling the flowers: sepals and petals oblong, 8 to 10^{mm} long; lip crestless, rather deeply 3-lobed near the base; the middle lobe 5 to 6^{mm} broad, suborbicular, the margin slightly crenulate and infolding; the lateral lobes widely spreading, oblong or obovate-oblong, 4 to 5^{mm} long: column short, 4 to 5^{mm} high: capsule erect, elliptic-ovoid, 2^{cm} long.— *Bletia verecunda* Chapm. Fl. 456, not Swartz. *C. Woodfordii* Chapm. Fl. (ed. 3) 482, not Lindl.

Common in the dry pine lands of eastern Florida, blooming throughout the summer (*fide* Curtiss). Near Jacksonville (type) and borders of Indian river (A. H. Curtiss, no. 2808), Tampa (A. P. Garber), near Eustis, and at Titusville (G. V. Nash, nos. 1571 and 2294). This plant has been generally known in American herbaria as *Bletia verecunda*, from which rose-colored species it is obviously very distinct. In 1881, in a letter to Dr. Watson, Bentham pointed out that the plant was a Cyrtopodium related to the West Indian *C. Woodfordii*. From that species it differs markedly in size, *C. Woodfordii* being a comparatively stout plant. The flowers of *C. ecristatum*, too, are much smaller, the lateral lobes of the lips more spreading, and the column much shorter than in *C. Woodfordii;* and the middle lobe of the lip, which in *C. Woodfordii* is sparingly crested, in *C. ecristatum* is quite naked. According to Mr. Curtiss, the flowers of the Florida plants are yellowish outside and purplish brown within.

ALTERNANTHERA PUNGENS HBK. Nov. Gen. et Sp. **2**: 206.

This South American and Mexican species, which has formerly been reported from Mobile,[1] has recently been found by Mr. Curtiss introduced about the streets of Pensacola (no. 5921).

JUSSIÆA SUFFRUTICOSA L. Sp. Pl. 388.

The first record of this plant in the United States was Dr. Small's recent note of Dr. Mohr's station at Mobile, Ala.[2] Mr. Curtiss found the plant in low ground at Pensacola, July 2, 1897 (no. 5918).

HYDROCOTYLE BONARIENSIS Lam. Encyc. **3**: 153.

This interesting tropical species, which has recently been reported by Mr. Pollard from Mississippi,[3] was collected by Mr. Curtiss in low grassy ground at Pensacola, July 3, 1897 (no. 5922), thus making known a second station for the plant in the United States.

SOLANUM ELÆAGNIFOLIUM Cav. Ic. **3**: 22. *pl. 243*.

This species, common in the southwestern states, has been found by Mr. Curtiss in ballast and along streets at Pensacola (no. 5913).

CHRYSOPSIS GRAMINIFOLIA Ell. var. **latifolia,** n. var.—Stouter than the type; the stems densely leafy: the silvery leaves broadly oblanceolate or oblong-lanceolate, strongly 5 to 7-nerved; the lower cauline 10 to 15^{cm} long, 2 to 3^{cm} wide, blunt or rounded at the tips; the upper shorter, with less rounded or acute tips: inflorescence less diffuse and of fewer heads than in the type; the bracteiform leaves linear-lanceolate, 2 to 3^{cm} long: heads as in the type, but the fusiform akenes longer, 4^{mm} long, and the pappus shorter, 6^{mm} long.

Collected in "spruce pine" land, Jensen, March 25, 1897, by A. H. Curtiss (no. 5819); and in 1874 in east Florida (no station given) by Dr. Edward Palmer (no. 259). A plant habitally well distinguished from *C. graminifolia*, but passing by various gradations to it. The akene and pappus characters, which on the whole are good, are not strictly to be relied upon. In typical *C. graminifolia* the akenes average 2.5 to 3^{mm} in length, but in large specimens they are fully 4^{mm} long, thus equaling those of var. *latifolia*. The pappus, too, of *C. graminifolia* is inconstant in its length. In most specimens it is 8 or 9^{mm} long, but specimens of good *C. graminifolia* are found with the pappus only 6^{mm} long. The var. *latifolia* is well distinguished habitally from the species by its approximate broad and obtuse leaves, which in the inflorescence become merely linear-lanceolate, not linear-subulate, as in the

[1] ULINE and BRAY, BOT. GAZ. **20**: 450.

[2] Bull. Torr. Bot. Club **23**: 129.

[3] Bull. Torr. Bot. Club **24**: 155.

species. But this habital character is shown not to be constant by Mr. Nash's no. 2313, which is exactly intermediate between *C. graminifolia* and the var. *latifolia*. Mr. Nash's plant has approximate acute leaves smaller than in var. *latifolia*, but at the same time much broader than in the true *C. graminifolia*. The akene of Mr. Nash's plant is like that of *C. graminifolia*, while the pappus is short as in var. *latifolia*.

SPILANTHES STOLONIFERA DC. Prodr. 5: 621.

This plant, previously known only from Brazil, Paraguay, and Uruguay, was found by Mr. Curtiss in low ground at Carrabelle, near Apalachicola, in June 1897 (no. 5882). The species is distinguished from *S. repens* by its lanceolate or linear-lanceolate, entire or remotely dentate, sessile or obscurely short-petiolate leaves.

MARSHALLIA ANGUSTIFOLIA Pursh, var. CYANANTHERA Ell. Sk. 2: 317.

Mr. Curtiss has recently found this well marked variety with Sarracenia, Tofieldia, etc., on seepy slopes of the pine barrens in Walton county, west Florida (no. 5932). The plant is distinguished from the handsome *M. angustifolia* by its slender simple stem, smaller, less conspicuous (Mr. Curtiss says "actually insignificant") heads, and by the short-acuminate involucrate bracts which are lanceolate or oblanceolate and much shorter than the linear-attenuate bracts of *M. angustifolia*. Mr. Curtiss has formerly collected the same form in the pine barrens of Liberty county.

ANTHEMIS MIXTA L. Sp. Pl. 894.

This common Mediterranean species was collected by Mr. Curtiss in 1886 on ballast at Pensacola. It has recently been sent by him from the same station (no. 5914), where it is apparently well established.

HIERACIUM MARIANUM Willd. var. SPATHULATUM Gray, Syn. Fl. 1²: 455 (Suppl.).

Several Florida specimens distributed as *H. Gronovii* are identical with authentic Pennsylvanian specimens (collected by Traill Greene and Porter) of *H. Marianum* var. *spathulatum*. Mr. Nash's *H. megacephalon*,[4] though a little more leafy, seems to be the same. As a variety of *H. Marianum* the plant seems tolerably well marked, but intermediate forms occur, notably a plant from Asheville, N. C., 1893 (B. L. Robinson, no. 26), which has the essentially radical and densely pubescent leaves of the variety, but the elongated paniculate inflorescence and somewhat smaller head of the species; and a leafy-stemmed plant from Garrett county, Maryland (John Donnell Smith), with the lower leaves pubescent as in var. *spathulatum*.

[4] Bull. Torr. Bot. Club 22: 152.

In distinguishing his *H. megacephalon* from *H. Gronovii* Mr. Nash emphasizes as a specific character of the former its early flowering season, March to May. As represented in the Gray Herbarium, the Florida specimens have been collected as early; but the Pennsylvanian specimens of *H. Marianum* var. *spathulatum*, which seem identical with the Florida plant, were collected early in July, and in the vicinity of Boston the typical *H. Marianum* often flowers by the middle of June. Furthermore, the Gray Herbarium sheet of Simpson's no. 575 (distributed as *H. Gronovii*) from Fort Myers, Fla., May 3, 1892, contains two plants, one of them *H. Marianum* var. *spathulatum*, the other somewhat intermediate between that and typical *H. Marianum*, but much nearer the latter. It would therefore seem that, though the var. *spathulatum* is a spring or early summer form, it is not entirely unique in its flowering season. The following Florida specimens of *H. Marianum* var. *spathulatum* have been examined: Fort Myers (J. H. Simpson, no. 575 in part), Lake City (F. C. Straub, no. 37), Port Orange (F. Straub, no. 86), Eau Gallie (A. H. Curtiss, no. 5818).

M. L. FERNALD, *Gray Herbarium, Cambridge, Mass.*

VIBURNUM DEMETRIONIS.

SINCE publishing *Viburnum Demetrionis* in the BOTANICAL GAZETTE (**22**: 166–7. 1896) we have secured ripe fruit from Mr. C. H. Demetrio, collected by his friend, Rev. E. Heck, at the type locality in central Missouri, August 30, 1896. This material furnishes the following supplementary characters:

Fruit somewhat fleshy, oblong in outline, rounded at the ends, 5 to 6 lines long, 3 lines broad, slightly compressed, shining, black; putamen oblong, strongly compressed, somewhat thicker and slightly pointed at one end; one surface with a median and two shallow intra-marginal grooves, the other with two (often indistinct) intra-marginal grooves; seeds thin, slightly concavo-convex.—W. DEANE and B. L. ROBINSON, *Cambridge, Mass.*

CURRENT LITERATURE.

BOOK REVIEWS.

Injury to plants by cold.[1]

THE prominent and peculiar feature of this research lies in the direct observation, by the use of the microscope, of the phenomena of freezing. A specially constructed box, with triple walls for the non-conduction of heat and for receiving a freezing mixture, enabled the author to enclose his microscope where objects were frozen during observation. On freezing colloids, emulsions and solutions, Molisch found, as others had found before him, that water, on becoming ice, separated itself from the contained material; but Molisch's microscope showed that the colloids formed a network of denser material, the emulsions formed a network of granules, and the solutions formed a network of concentrated or solid substance. Each of these networks contained ice-masses in the meshes. On thawing, the network disappeared *quickly in some of the liquids, but only slowly in others* such as starch paste, which is permanently altered by the freezing.

The author next experimented with the freezing of living bodies, using amœbæ, hyphæ of *Phycomyces nitens*, yeast, Spirogyra, and other algæ, hairs of Tradescantia, and the guard cells of stomata. The results obtained here are directly comparable with those obtained with merely physical bodies. The protoplasm on freezing became a network of denser material, with lumps of ice in the meshes. The capillary filaments of Spirogyra and Phycomyces gave up much of their water to the formation of an external ice mantle, and ice formed internally only at a temperature many degrees below zero, this being comparable with the well-known fact that ice forms in purely physical capillary tubes only when the temperature is several degrees below zero. The guard-cells of stomata were found to form ice only when considerably below zero; and this phenomenon the author explains by the greater content of dissolved substance in these cells, and by their capillarity.

In the next section of this monograph, Molisch seeks to answer the question as to whether plants die from freezing or thawing. Like Göppert, Sachs and Müller-Thurgau, he has tested hundreds of plants by the slow and by the rapid process of thawing, and like all but Sachs he finds, with the excep-

[1] MOLISCH, HANS.—Untersuchungen über das Erfrieren der Pflanzen. Gustav Fischer, Jena, 1897.

tion of one plant, that the slow thawing does not restore to activity. The sole exception was that of excised leaves of *Agave Americana*. If these were frozen in a not too low temperature, slow thawing restored more cells to activity than did rapid thawing. Göppert's work in using the change in color in the indican-holding blossoms of orchids as a test for the death of the protoplasm, was imitated by Molisch in using three marine Florideæ, Nitophyllum, Gelidium and Plocamium, red algæ which become orange on dying. In this test the orange color always came when the plants froze. The author had previously found that the plant *Ageratum Mexicanum* exhaled the odor of cumarin on dying. He therefore used this plant also as a test, and found the cumarin odor appearing when the plant froze. To the reviewer this work on the Florideæ and Ageratum seems the most important part of the whole paper.

The injury to plants by temperature just above o° was also studied. Molisch concludes, as others have before him, that in many cases the injury is due to excess of transpiration over absorption of water. In other cases the injury cannot be due to this cause, for it takes place when transpiration is checked by external means. Molisch believes that the injury in such cases is due to a disturbance of the metabolism of the organism, and suggests that there may result the accumulation of some toxic product, or a failure in the production of some necessary substance. Many plants, all from warm climates, were used in obtaining this result. A plant especially sensitive was *Episcia bicolor*, whose leaves became brown and contained mostly dead cells after an exposure of four days to a temperature of 3°. Preventing transpiration, shielding from the light, very gradually changing from a warm to a cold temperature, made no difference. Nearly all the species of plants used died within thirty-five days; a few lived two and one-half months; while two plants of *Philodendron pertusum* lived through the winter in the cold, but suddenly died in the first warm days in March.

Lastly, Molisch comes to the theory of death by freezing. Death comes with freezing, not with thawing, and is due to the withdrawal of water from the protoplasm. Thus Molisch finds himself in complete accord with Müller-Thurgau, who has given us a like explanation. The reviewer is not disposed to object to this conclusion in a general way, but would suggest that there are various phenomena, some of which are mentioned in the present paper, that do not come into harmony with the theory. To mention one of these is enough: Müller-Thurgau has found, and Molisch accepts the result, that the more the temperature is lowered, the more is the ice formed, and consequently the more is the water withdrawn from the protoplasm. Molisch states that wilted plants are less likely to be injured by frost than not wilted. This query, of course, comes: Why, according to the theory of injury by freezing, should not a given low temperature leave as much water in the protoplasm of a turgid plant as in that of a wilted plant?—F. C. NEWCOMBE.

Lectures on Bacteria.[2]

The multiplication of text books of bacteriology written from the standpoint of pure science rather than from that of medicine or technical industry is a hopeful sign. It means, let us trust, the ultimate correction of the asymmetrical development of the subject observable in the last few years, and may perhaps presage a certain reaction from the feverish search after all manner of "curative sera." In fact, continued advance along practical lines is possible only if the broader field is sedulously cultivated. The significance to agriculture, for example, of Winogradsky's work upon the nitrifying organism cannot perhaps be overestimated, but it is increasingly apparent that more research into the purely scientific aspects of nitrification must be forthcoming before we can hope to apply practically the results already obtained. The rescue of the subject of bacteriology from too exclusive devotion to test tube and guinea pig, and the return to the more wholesome if less sensational biological methods, will be forwarded by books like these "lectures" of Fischer.

The lectures contain a full disquisition upon the morphology and systematic position of bacteria, the structure of the cell being viewed, so to speak, from the standpoint of a plasmolysist. Bütschli's conception of the "central body" is, of course, stoutly opposed. Nearly one-third of the book is wisely given up to a description of the part played by bacteria in the transformation of nitrogen and carbon compounds; and the fundamental questions of putrefaction, nitrification, nitrogen-assimilation, fermentation, etc., are lucidly, if somewhat didactically, treated. Thirty pages (out of 160) are given to a consideration of bacteria in the rôle of excitants of disease, but in this brief space the author endeavors to set forth the true inwardness of serum therapy, devotes a word and a picture to the phagocyte theory, and has a paragraph even for the new tuberculin preparations "TO" and "TR!" A series of 164 notes at the end of the book, with references to pages of the text, contains some very useful bibliographical material, and serves to bring the lectures quite abreast of our knowledge. Fischer finds himself wholly unable to accept the remarkable observations of Stutzer and Hartleb[3] on the nitrifying organisms (note 72), and completely rejects the notion of extreme polymorphism advanced by these authors, whose investigations he characterizes as "full of gaps and entirely inadequate."— E. O. J.

MINOR NOTICES.

In Merck's Report for August 15 and September 1, Mr. Frederick LeRoy Sargent has a paper on the Ununculaceæ, giving a general account of the morphology of the family.—C. R. B.

[2] Fischer, Dr. Alfred.— Vorlesungen über Bakterien. 8vo. pp. 186. Jena: Gustav Fischer, 1897. *M* 4.

[3] Centrabl. f. Bakt. 3^2: 1897.

A REVISION of the North American Lemnaceæ has been published by Mr. Charles Henry Thompson.[4] It seems that this is the first revision of the North American species, and is based upon a study of the rich Engelmann collection, with Dr. Engelmann's notes and sketches, together with material from the most important collections of the country. The study of herbarium material was supplemented by an examination of abundant living material of nearly every species. The group is difficult on account of its polymorphism, showing two or three distinct phases. The vegetative and reproductive phases result in different looking plants, and the "resting phase," when it occurs, is different from both. Naturally these various phases have brought confusion into descriptions. Spirodela is represented by its single well known species, Lemna contains six, Wolffiella three, and Wolffia three, one of which is new. The contribution is a very valuable bringing together of material.—J. M. C.

A BRIEF ACCOUNT of the life and work of the late Fredrick Wilhelm Klatt is given in the *Bulletin l'Herbier Boissier*,[5] by Dr. Hans Schinz. He was born in Hamburg, February 13, 1825, and died March 3, 1897. He was best known to American botanists by his studies of the Compositae of the American tropics. The bibliography prepared by Dr. Schinz contains forty-nine titles, extending from 1856 to 1896.—J. M. C.

THE SERIES of papers upon "North American Coniferae," published by Dr. Edson S. Bastin and Mr. Henry Trimble in the *American Journal of Pharmacy*, from January 1896 to July 1897, have been brought together in a convenient pamphlet form.—J. M. C.

PARTS 155 to 158, and 161 to 163 of *Die Natürlichen Pflanzenfamilien* are supplements to the second, third, and fourth volumes. Much interesting new material is brought together, and many of the families are brought up to current knowledge. It is interesting to note that the recent discovery of spermatozoids in Cycas and Ginkgo (their discovery in Zamia being too recent to be included) has led to a modification of the characters assigned to gymnosperms, and has induced Dr. Engler to separate the genus Ginkgo from the conifers and make it the type of a distinct family, the Ginkgoaceæ, to which five or six fossil genera also belong. It is strange that this has not been done long ago, even before the spermatozoid discovery. The gymnosperms are further recast by recognizing six great groups ("classes" of Engler) instead of the usual four. We have been accustomed to cycads, cordaites, conifers, and gnetums; but the Engler classes now are Cycadales, Bennettitales, Cordiatales, Ginkgoales, Coniferae, and Gnetales. The numerous further changes in the grouping of

[4] Separate from the ninth annual Report of the Missouri Botanical Garden, pp. 22, *pl. 4*. 1 N. 1897.

[5] 5: 836–839. 1897.

the gymnosperms cannot be noted; but it is with some regret that we abandon the famous name *Welwitschia mirabilis* for *Tumboa Bainesii*. An interesting addition is also made to the literature of the morphology of angiosperms in presenting and illustrating the results of Guignard's work on *Lilium Martagon*. Parts 159 and 160 contain Sphaeriales and Laboulbeniineæ by G. Lindau, and Hemibasidii (Ustilagineæ and Tilletiineæ) and Uredinales by P. Dietel.—J. M. C.

A RECENT CONTRIBUTION from the Gray Herbarium contains the results of Mr. Fernald's recent studies.[6] The first part presents a systematic study of the United States and Mexican species of Pectis. A full historical sketch of the various groupings of the species precedes the synoptical presentation. Thirty-eight species are recognized, and are grouped under five subgenera, Eupectis, Pectidopsis, Pectothrix, Heteropectis, and Pectidium. Six new species are described. The second part contains descriptions of rare and undescribed species collected by Dr. Edward Palmer at Acapulco, Mexico.—J. M. C.

TEACHER'S LEAFLETS, no. 8,[7] is intended to give teachers a knowledge of the minute points of difference in leaves and acorns of the white, bur, chestnut, swamp white, red, scarlet, and black oaks. It is written by Mr. A. P. Wyman and contains illustrations of the leaves and acorns of each kind described. These leaflets must be of great value to teachers who are expected to conduct nature study in primary schools.—C. R. B.

A BOOK of laboratory directions intended primarily to accompany Sedgwick and Wilson's *General Biology* has been prepared by Dr. Harriet Randolph[8] of Bryn Mawr College. This provides specific directions for laboratory work, occupying about six hours a week for the collegiate year. The forms treated are fern, earthworm, amoeba, white blood-corpuscle, lichen, mushroom, bacteria, spirogyra, hydra, mussel, lobster, moss, frog, fish, pigeon, and rabbit. There are also laboratory directions for the study of the stem, bud, leaf, and seed of plants and the circulation of protoplasm, and for the embryology of the frog and chick. The directions are well arranged but seem to us too brief and likely to induce superficiality, especially in view of the short time allotted to each organism. The fern (Pteris) cannot be studied properly in ten hours, the moss (Polytrichum) in five and Penicillium, a lichen and a mushroom in four, unless the students are vastly more expert than most beginners.—C. R. B.

[6] FERNALD, M. L.—Contributions from the Gray Herbarium of Harvard University. From Proc. Amer. Acad. **33**: 57–94. 1897.

[7] Teachers Leaflets on nature study: prepared by the College of Agriculture, Cornell University. Address Chief Clerk, as above, Ithaca, N. Y.

[8] RANDOLPH, HARRIET.—Laboratory directions in general biology. 12 mo. pp. vi + 163. New York: Henry Holt & Co. 1897. 80 cents.

THE PREVALENCE of tubercle bacilli in market butter has been made the subject of especial investigation of late by a number of workers. Groening[9] and Obermüller,[10] working independently, have found that a large percentage of samples of butter are able to produce in guinea pigs pathological lesions that were similar to tuberculosis. Smear preparations made from the diseased tissues showed the presence of bacilli that reacted toward stains in a manner similar to the tubercle organism. Groening found in eight out of seventeen cases, bacilli that he identified as tubercle bacilli, although in this determination he omitted to make cultures and critically study the isolated organism. Obermüller's results were even more startling, for in every sample examined (fourteen in number) tubercle bacilli were found.

Lydia Rabinowitsch[11] has recently made a thorough examination of a large number of samples (thirty in Berlin and fifty in Philadelphia) and her results throw grave doubts on the previous results mentioned. She finds in a considerable number of samples (28 per cent.) an organism able to produce in guinea pigs lesions which resemble, microscopically as well as macroscopically, the genuine tubercle bacillus so closely that the two can only be differentiated by the aid of cultures. Furthermore, in not a single case were tubercle bacilli found which agreed in all particulars with the type descriptions. The organism that so closely resembles the true tubercle germ is mildly pathogenic for guinea pigs but not for other animals. Culturally, and in its reaction toward tuberculin, it is readily distinguished from *Bacillus tuberculosis*.

These careful investigations render it extremely probable that the results of other investigators have been misinterpreted owing to the lack of more thorough study of the supposed tubercle organism.— H. L. RUSSELL.

THE PROCEEDINGS of the Indiana Academy of Science for 1896, just issued, bear evidence of a marked botanical activity in that state. Twelve papers upon botanical subjects are published in full, while nearly as many more appear by title only. As might be expected from the organization of a State Biological Survey by the Academy a few years ago, many of the papers are in the nature of contributions to the flora of the state. Those treating of the spermatophytic flora are Messrs. Stanley, Coulter, Hessler, Blatchley, and Chipman. The interesting fact concerning these papers is that they indicate in a marked degree the passing of the day of mere lists of names, and the beginning of local studies of plants in relation to their surroundings. The paper of Dr. Robert Hessler upon the "Flora of Lake Cicott and Lake Maxinkuckee," and that of Mr. W. W. Chipman upon the "Flora of the lake region of northeastern Indiana," in their presentation of the physiographic conditions of the areas studied, in their indications of

[9] Groening, Cent. f. Vet. Viehmarkt. u. Schlachthoflangeleg, 1897, nos. 14–15.
[10] Obermüller, Hyg. Rund. 1897, no. 14.
[11] Rabinowitsch, Zeit. f. Hyg. **26**: 90. 1897.

physiographic changes consequent upon the reclamation of swamp lands, and in their notes upon the plant movements necessitated by these changes, bring together a mass of facts of extreme interest and value. Mr. Blatchley, under the title of some "Phanerogams new or rare to the state," records the stations and habitats of ninety-three species, of which thirty-three have not heretofore been recorded as occurring within the state, the remainder being recorded from a single station only. In "Contributions to the flora of Indiana, No. IV," Professor Stanley Coulter discusses "The Compositæ of the state with special reference to their distribution." Of the two hundred and thirteen specimens recorded, it is shown that thirty-six species are reported from a single station; that eight species are strictly northern, twenty-four southern, and one western in distribution within the state; and that the remaining one hundred and forty-four species are of general distribution. Preceding the discussion of the distribution of the species there is given a brief summary of certain experiments touching the germination of Compositæ and the power of resistance shown by seedlings to temperature and moisture changes. These experiments promise to yield results of exceptional importance, and are of more than passing interest.

Additions to the cryptogamic flora of the state are made by Dr. L. M. Underwood and Dr. J. C. Arthur. Miss Lilian Snyder contributes an article upon "The Uredineæ of Tippecanoe county," noting seventy species, fifteen of which have here their first record for the state.

In physiological botany Professor M. B. Thomas discusses "Periodicity of root pressure," arriving at the following general conclusions: the periodicity of root pressure seems to be inherent in the plant, and has either been acquired by previous adaptation to environment, or is the result of the action of some constant or periodic changes in the plant; root pressure does not seem to have any relation to the previous periodicities of the vital activities of the plant when the top was connected with the roots; the measure of the root pressure seems to be the osmotic activity of the root hairs, and is probably due to the presence of organic acids and other substances in the rhizoids that show great affinity for water; although the organic acids increase in the cells at 50°–60° F., their increase does not seem to make any appreciable difference in the periodicity, this being true even when the temperature of the soil is brought up to 55° F., approaching the time of minimum pressure.

Katherine E. Golden records a series of experiments undertaken to determine whether or not the common yeasts have pathogenic properties. Rabbits and guinea pigs were used in the work, the results indicating that yeasts when taken into the stomach of those animals cause neither discomfort, nor lesions in any organ, even when a fermentable substance be eaten at the same time. Injections from wort cultures of yeast were also made in the case of both animals, to note the effect of yeast when introduced into the circulation, but in no case could ill effects be observed. The results of the

experiments agree in the main with those of Neumayer except that he claims that an injury to an animal may always be expected if fermentable substances be taken at the same time as the yeasts.

Professor A. W. Bitting and Charles E. Davis, as the result of a study of "The bacteriological flora of the air in stables," give descriptions and illustrations of eighteen forms studied in detail.

"A revision of the species of the genus Plantago occurring within the United States," by Alida M. Cunningham, suggests an arrangement of species based upon seed characters, in the belief that such characters are most likely to be constant and of diagnostic value. According to Miss Cunningham, the genus may be broken up into three sections, clearly separated by seed characters as follows:

(1) Seeds oval in cross section (*P. cordata, Major, Rugelii, eriopoda, decipiens, maritima, Tweedyi*); (2) seeds more or less anther shaped in cross section (*P. lanceolata, Patagonica, hirtella, Virginica, rubra, minima?*); (3) seeds irregularly lobed in cross section (*P. elongata, heterophylla, Bigelovii*). Miss Cunningham considers that no good reason exists why vars. *aristata* and *gnaphalioides* of *P. Patagonica*, and var. *longifolio* of *P. Virginica* should be raised to specific rank, concluding from seed characters that they should still be considered as varieties. *P. decipiens*, however, she believes, should not be included under *P. maritima*, being clearly separable from that species. So far as examined, all forms labeled *P. major*, var. *Asiatica*, are referable to either *P. major* or *P. Rugelii*. Two new species, *P. rubra* and *P. minima*, are described; *P. rubra* being separated from *P. Virginica* by the dense hairs, acute sepals, shape and dehiscence of capsule, color, cross section and size of seeds; *P. minima* being closely allied to *P. Patagonica*, var. *gnaphalioides*, and separated from it by size, surface of sepals, size of capsule, color, size and surface of seed. The material examined by Miss Cunningham embraced the collections of the National Herbarium, the Herbarium of the University of Minnesota, the Herbarium of Professor John M. Coulter, and that of Purdue University. The work has been done with extreme care, and the analytic keys and figures accompanying the article add greatly to its value.

Miss Clara Cunningham, in a concisely written paper accompanied by two plates, gives the result of experimental studies concerning the "Effects of drought upon certain plants." The result of the experiments served to show that immature plants, subjected to drought even for a very short time, undergo decided changes, not merely in general appearance, but also in structural details.

The volume of proceedings itself is fairly good, so far as the letter press goes, but the proof reading is inexcusably careless in parts, while the plates in the main are admirable illustrations of how plates should not be printed. The work of the Academy is excellent, that of the state printer is not beyond reproach.

NOTES FOR STUDENTS.

ITEMS of taxonomic interest are as follows: Illustrations of *Hypericum galioides*[12] and *H. lobocarpum*[13] have appeared in recent numbers of *Garden and Forest.* W. W. Ashe[14] has prepared a synoptical presentation of the genus Asarum in eastern America, recognizing eight species, four of which are described as new. E. L. Greene[15] has published a fascicle of new species of Trifolium, seventeen in number, also five new species of Streptanthus has segregated two new species from the Apocynum forms of the eastern United States, has described five new species of Eriogonum, has recognized the "hop trefoils" as a good genus bearing the name *Chrysapsis* Desvaux (1827), substitutes *Anthanotis* Raf. for *Podostigma* Ell., and says that *Arafallus* Necker should be used for *Oxytropis* DC. rather than *Spiesia* Necker. A. A. Heller[16] substitutes the generic name Edwinia forthe well known *Jamesia* T. & G. (1840), since Rafinesque has used the latter name in 1832, an unfortunate change which he tries to moderate as much as possible by using the given name of Mr. James. E. Koehne[17] has published further studies of Lythraceæ, among which are included many tropical American forms. C. V. Piper[18] has described a new Rubus from the cañons of Washington, naming it *R. Hesperius.*[19] Carl Purdy has described two new species of Lilium from California and Washington. J. K. Small[20] has described a new oak, *Quercus geminata*, from Florida, also two new species of Celtis, one from Georgia, *C. Georgiana*, the other from Texas, *C. Helleri*, and has published a revision of the species of Gaylussacia in the southern states, recognizing seven species.—J. M. C.

ALBERT KATTEIN, after a study of the development of the vascular bundles of roots and stems, agrees with Van Tieghem and others that the central cylinder of the root is homologous with the bundle complex of the stem rather than with a single bundle, as held by Russow and DeBary. It follows that the pith of the central cylinder when present is homologous with that of the stem in dicotyledons.[21]—C. R. B.

ONE OF THE most interesting papers that has recently appeared is a consideration by Stahl of the cause of nyctitropic and related movements.[22] The author believes that the common view advanced by Darwin, that the movements are to prevent the radiation of heat, can scarcely be the chief cause.

[12] Garden and Forest **10**: 433. 1897.
[13] *Ibid.* 453.
[14] Botanical contributions from my herbarium **1**: 1–4. 1897.
[15] Pittonia **3**: 199–230. 1897.
[16] Bull. Tor. Bot. Club **24**: 477. 1897.
[17] Engl. bot. Jahrb. **23**: 17–36. 1897.
[18] Erythea **5**: 103. 1893.
[19] *Ibid.* 103–105.
[20] Bull. Torr. Bot. Club **24**: 438–445. 1897.
[21] Bot. Centralbl. **72**: 55. 1897.
[22] Ueber den Pflanzenschlaf und verwandte Erscheinungen. Bot. Zeit. **55**[1]: 71–109. 1897.

Stahl regards nyctitropic and other related leaf movements to be most intimately connected with the process of transpiration or, in other words, the conduction of solutions from the soil. This view is supported by a large number of facts that are admirably brought into harmonious relationship with each other. True nyctitropic movements are believed to facilitate nocturnal transpiration; in accordance with this view Stahl finds that the stomata of these plants are open at night, and that the leaves, on account of their vertical position, are much less strongly bedewed than are ordinary horizontal leaves.

The absence of dew, of course, facilitates transpiration, and the loss of water is still further favored by the fact that the leaf surface most fully provided with stomata is best concealed from the dew.

Some of the tropical plants, especially legumes, assume the vertical or profile position in strong sunlight. In such cases the movements are undoubtedly to reduce the transpiration, since the danger here is from too great, not too little loss of water. The autonomous movements of *Desmodium gyrans*, which have been hitherto unexplained, are thought to be for the purpose of promoting transpiration, since the movements cause the saturated air to be driven off, thus allowing dry air to come in contact with the transpiring surface. The quaking aspen and other poplars may secure the same results by means of the passive movements of their leaves.

Stahl thus associates all variation in leaf movements in one way or another with transpiration, and the predominantly tropical distribution of plants that show such movements is a strong point in favor of this view. It is a striking fact that the Leguminosæ furnish the larger proportion of plants, and Stahl hints that as they have worked out such delicate apparatus to regulate the transpiration, a condition resulting, perhaps, in a more uncertain food supply, so the strange rhizobium symbiosis, characteristic of the family, may have been assumed to supply the deficit of nitrogen.—H. C. C.

KOHL HAS BEEN carrying on studies in order to ascertain the photosyntactic energy of light of various colors.[23] Engelmann's observations showed that the energy of absorption is a mark of the energy of photosyntax. Kohl accepts these results and conducts experiments on algæ placed in darkened chambers covered with colored glasses. He finds that red light permits about 50 per cent. of the photosyntax of white light, blue light nearly as much green light about 25 per cent., yellow light 12 per cent., and violet still less. The results from blue light are surprisingly large, and are hard to interpret in connection with Sachs' well-known experiments.—H. C. C.

DR. A. J. EWART'S paper[24] on the evolution of oxygen from colored bacteria details some interesting results. He finds that a considerable number

[23] Ber. der deutsch. bot. Ges. **15**: 361–366. 1897.

[24] Jour. Linnean Society **33**: 123.

of the chromogenic bacteria have the power of evolving oxygen. This is demonstrated in the following manner: A small quantity of the chromogene to be tested is placed on a cover glass, and to this is added a drop of fluid but cool gelatin. When solidified a drop of water containing actively motile aerobic organisms is also added, and the whole at once covered. If certain chromogenic bacteria are used, the motile forms in close proximity to the gelatin will continue to move for hours, whereas such movement is suspended in a few minutes if no chromogenic culture is added. Further proof that the evolved gas is oxygen is shown by the ability of the gas to reoxidize reduced indigo carmine. The addition of $HgCl_2$ stops the evolution, and as it occurs in darkness, it cannot be regarded as a photosyntactic product. Ewart arrives at the conclusion that the evolution is a purely physical process, the bacterial pigment having the power of absorbing oxygen, then gradually evolving it again. The oxygen is held in much the same way as it is in oxyhaemoglobin. The biological significance of this process is a question asked but unanswered.

The chlorophyllose and purple bacteria are also considered in relation to their oxygen evolving properties. Engelmann's proof for the evolution of oxygen from these green bacteria was by exposing them to cultures of some spirillum, but Ewart claims to have been able to isolate chlorophyll from cultures of these forms. He also shows that the purple bacteria likewise have photosyntactic powers, although this property is not marked. The conclusion is that the evolved oxygen in these cases is the result of photosyntactic activity.—H. L. RUSSELL.

THREE STATION bulletins of recent date having botanical interest are the following: J. C. Whitten (Mo. no. 38, pp. 140–164) shows with excellent data that the winter killing of the flower buds of peach may be greatly lessened by shading the tree with board or cloth screens, or by covering the branches with whitewash. One cuts off the direct rays of the sun, and the other reflects them. The former is especially effective, while the latter saved 80 per cent. of the buds when only 20 per cent. survived unprotected. J. F. Duggar (Ala. no. 87, pp. 459–488) gives the result of inoculating the soil for vetch, peas, clover, lupine, and other leguminous plants, with soil in which such plants had previously grown and with the imported commercial article, known as nitragin, in both pot and field culture. Results largely favored the inoculated plants. P. H. Rolfs (Fla. no. 41, pp. 517–543) announces the occurrence in Florida, and possibly in California, of an important fungous parasite of the very destructive San Jose scale insect. It is *Sphaerostilbe coccophila* Tul., native of warm countries, United States and elsewhere. It clears the tree of insects more thoroughly than any artificial means so far devised. The infection is easily disseminated from both natural and laboratory grown material.—J. C. A.

A BULLETIN (no. 9), prepared by Professor L. H. Pammel, has just been issued by the government Division of Agrostology. It deals with the grasses and forage plants of Iowa, Nebraska, and Colorado. The three divisions of the bulletin deal with the following subjects: General observations upon the physical conditions and other important questions in reference to forage in these states; a list of the more important grasses and forage plants of the region; and a list of the grasses of the three states collected by Professor Pammel during 1895 and 1896.—J. M. C.

DR. SMITH ELY JELLIFE has published in the *Journal of Pharmacology* (Nov.) a very useful paper entitled "On some laboratory molds." It deals with the more common molds and yeasts in a descriptive way, text cuts being used, and analytical keys provided. The purpose is to aid in the rapid identification of such forms as may arise in connection with the various laboratory cultures.—J. M. C.

THE INTEREST in mushrooms and mycophagy generally is not very widespread in the United States. Those acquainted with the real nutritive and gastronomic worth of fleshy fungi wonder that they do not become a standard food for both rich and poor. Every aid toward this end should be heartily welcome. The last contribution to the subject is a bulletin (no. 138) from the Cornell Experiment Station, by Geo. F. Atkinson,[25] which gives a very full account of two common mushrooms, *Agaricus campestris* and *Lepiota naucina*, and of a poisonous species, *Amanita phalloides*. The attempt has been made to give such clear, detailed and untechnical descriptions of these plants, aided by carefully prepared illustrations, that the novice may identify them with reasonable certainty, and moreover find himself attracted toward the subject. All but two of the cuts are from photographs, and more perfect illustrations in black and white could hardly be made.—J. C. A.

[25] GEO. F. ATKINSON, Studies and illustrations of mushrooms. Bull. Cornell Exper. Sta. no. 138, pp. 337–356, *figs.* 27. Ithaca, September 1897.

NEWS.

PROFESSOR W. BELAJEFF, of the University of Warsaw, has been appointed director of the botanic garden of Warsaw.

MISS ANNA ARMA SMITH has been appointed assistant in botany in Mt. Holyoke College.

DR. A. O. KIHLMAN, docent in the University of Helsingfors, has been promoted to an assistant professorship of botany.

OIL DISTILLED from birch tar is coming into increased use for imparting the characteristic odor of Russia leather to all sorts of thin leather in the manufacture of fancy articles.[1]

MR. EDWIN B. ULINE has just received the Doctor's degree from the University of Berlin, where he has been at work for two and a half years. He will return to America early in January.

ATTENTION is called to the fact that the authorized agent in Germany for the BOTANICAL GAZETTE is now the well-known publishing firm of Gebrüder Borntraeger, 46, den Schönebergerstrasse 17a, Berlin, S. W.

THE STATES of Michigan, New York, and Indiana, together with a few scattered localities, produced this year about 250,000 kilos of peppermint oil, as against less than 200,000 for 1896. About one-third the total product is sent to Germany.

THE SETS of Colorado plants prepared by Mr. C. F. Baker during 1896, and advertised in this journal, have all been sold. The specimens were well selected and preserved, and were mostly purchased by the larger institutions and added to the working herbaria.

THE NINTH SECTION of the wall charts of Professor Kny, consisting of plates 91–100, has recently been issued by Paul Parey, Berlin. These illustrate the structure and development of the glandular hairs of lupine; the pollination of *Aristolochia Clematitis;* and the development of *Aspidium Filix-mas*. To the latter, eight of the ten plates are devoted.

THE WASTE CEDAR from lead pencil factories is the chief source of the raw material for the distillation of cedar oil, which is extensively used by

[1] SCHIMMEL & Co., Semi-Annual Report, Oct. 1897, p. 7.

manufacturers of cheap soaps. The demand for the oil is increasing so that this source threatens to become inadequate, in which case the wood in blocks will have to be used. This would make the oil four to six times as costly as at present, say Schimmel & Co.[2]

IN THE *Popular Science Monthly* for September there are three matters of botanical interest: (1) an illustrated account of the giant cactus, by Professor J. W. Toumey, who is certainly most competent to deal with such a subject; (2) an interesting paper on the scope of botany, by Dr. George J. Peirce, now of Stanford University; and (3) a sketch, with portrait, of Professor Samuel Lockwood, who was one of those charming old-time "naturalists" who are fast disappearing.

THE TREATISE on diatoms which Dr. Henri van Heurck had long in preparation has just been published in England, translated by Mr. Wynne E. Baxter. It forms a handsome volume of 600 pages, illustrated by about 2000 figures. All recognized genera of the world, 192 in number, are figured and also representatives of many rejected genera. All species of the North sea and countries bordering thereon are figured and described. A French edition may be published provided enough subscriptions are obtained to promise its success.

THE MUSHROOM PLATES accompanying Mr. Charles H. Peck's report for 1894 as state botanist of New York, which excited so much interest when issued a few months ago that the edition was speedily exhausted, have been ordered by the Regents to be reprinted in an edition of 1000 copies in the form of wall charts. They can be had in sheets or mounted upon rollers. It is a pity that plates that have attracted so much attention and from which so much is expected are not less crudely executed. The coloring has only sufficient fidelity to nature to be remotely suggestive.

THE SECRETARY OF AGRICULTURE has included in his estimate of the expenditure for the coming year an item of $20,000 to be set aside from the seed fund for the introduction of valuable economic plants. In case this expenditure is sanctioned by Congress, Mr. D. G. Fairchild will be put in charge of the work. If the scheme of seed distribution ever had in it a scientific purpose, that purpose will certainly be carried out more wisely by this method suggested by the Secretary. The importance of such work no one, can doubt, and the fitness of Mr. Fairchild, who has traveled so extensively, is at once apparent.

THE BIOLOGICAL SURVEY of Alabama is being developed and extended as rapidly as limited means will permit. Over 20,000 specimens have been added to the herbarium collections during the present year, including fine

[2] *Ibid.* p. 13.

series of mosses, lichens, and hepatics. Much of the success of the work is due to the activity and devotion of Professor F. S. Earle, and Mr. Carl F. Baker of the Alabama Polytechnic Institute and botanists of the survey. It is contemplated to offer sets of exsiccatae at about $7.00 per hundred, and also to make exchanges to some extent, in order to provide additional funds and material for the herbarium.

GEBRÜDER GOTTHELFT, of Cassel, announce the early publication of a new set of wall charts in five series: 1, physiology; 2, anatomy; 3, taxonomy and phylogeny; 4, morphology; 5, diseases. Dr. F. G. Kohl, professor of botany in the University of Marburg, will prepare the original drawings or select those of other authors to be reproduced. These will be largely from photographs. A larger size than usual, 85×115^{cm} will allow the lines to be coarse enough to be seen in a large lecture hall. The price is to be reasonable, viz., *M* 5 per chart, unmounted; if mounted with rings and roller, *M* 2 additional. Single charts may be purchased, or any series. Sample plates will be sent free on request.

THE APPEARANCE of the *Plant World* justifies its announcement. Two numbers are now before us, and a statement of contents is the best sort of comment. The October number contains "The sword moss," by Mrs. E. G. Britton; "The families of flowering plants," by Charles L. Pollard, the beginning of a series of articles; "Sensitiveness of the sundew," by F. H. Knowlton; "Ferns of the Yosemite and the neighboring Sierras," by S. H. Burnham; "Some sand-barren plants," by Willard N. Clute. There is also an editorial department and one of "notes and news." The November number contains articles by F. H. Knowlton, Charles L. Pollard, A. A. Heller, Arthur Hollick, and W. J. Beal. We hope that the journal has "come to stay."

THE FOLLOWING reliable information about the cultivation of orris (*Iris florentina* L.) may be of interest, as it is of great importance to the perfumery industry and little has been known about it. The cultivation of this plant has been going on in Italy for two centuries. It is planted on hills and hillsides, never in valleys; mostly on sunny clearings or lengthwise between rows of vines in vineyards, seldom in extensive fields. It grows only in dry stony ground. Once planted, the plants need no further care and are left undisturbed for two or three years. Then the gathering of the rhizomes commences. Half the last joint is left on the living plant, which is replanted in new ground at once or within a fortnight. The freshly cut rhizomes are first placed in water to facilitate peeling, after which they are dried in the sun. 100 kilos of green rhizomes make 30–40 kilos of dried. The Tuscany districts will yield this year about 1,250,000 kilos.[3]

[3] SCHIMMEL & CO., Semi-Annual Report Oct. 1897, p. 38.

THE BAUSCH & LOMB OPTICAL CO. announce their intention to begin the publication, on January 1, of an octavo sixteen-page monthly periodical devoted exclusively to the science involving the use of the microscope, particularly in the line of practical methods of working, the description of new apparatus and the recording of new uses for already described appliances, new and useful formulæ for staining, fixing, mounting, etc., news about prominent men and institutions both domestic and foreign, correspondence and criticism and current literature. The paper and printing are to be of the best, and accurate illustrations will be provided when required.

It is proposed to conduct this journal in the most conservative manner as to the accuracy and practical value of the matter. As there is at present no publication in this country devoted to the above mentioned subjects exclusively, the company has been repeatedly urged to establish and maintain such a periodical. They hope to receive the hearty support of all interested in the advancement of science.

GENERAL INDEX.

The most important classified entries will be found under Contributors, Diseases, Hosts, Necrology, Personals, and Reviews. Names of new species are printed in **bold-face type**; synonyms in *Italics*.

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